

The Essential Guide to RC Cars

By Neil Waterhouse

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Preface

Welcome to the fun, exciting and now relatively inexpensive world of Radio Control Cars! My goal for this book is too try and pass on some of the knowledge I have gained over the last 20 plus years of not only racing RC cars but also teaching hundreds others who have asked for help.

I was 13 years old when I got my first RC car. It was an electric 6 volt Tamiya road car with a manual servo operated speed control. Back in those days cars did not come fully assembled but instead came in a large box and in what seemed like 1,000 pieces. Everything had to be screwed together, even the gearboxes and differential(s) had to be assembled from a ton of parts.

This car was to be a Christmas present from my mum back in 1980 and she thought it would be a great present as it would keep me busy screwing it together for the rest of the school holiday. What she didn't realise was this present was purchased 2 weeks prior to Christmas and was sitting under the tree wrapped up and I was getting home at 3:30pm in the afternoon and she didn't get home until 5:00pm.

This gave me 90 minutes a day to carefully slide the box out of the Chrissy paper and start building. I will never forget her face when I opened the box on Christmas day and there was a fully assembled RC car including a fully charged battery!

I first started racing RC cars when I was 14 at as it was then called the Sydney Showground now called Fox Studio. I have fond memories lugging 2 eskies from my home in the Northern Suburbs of Sydney Australia onto a bus to Manly, a ferry to the city, then another bus to the showground and then walking with 2 big heavy eskies full of batteries, chargers, tools etc! Thankfully my mum graciously accompanied me and helped cart the eskies. Despite being the youngest at the club I learnt a lot and even won a few races. I still remember my first trophy which was for all things at a Jumping Competition at Warringah Mall in Sydney's northern beaches. The competition was to see which car could jump the furthest and keep driving. The night before I had stayed up almost all night building an engine which I thought would either self destruct or stand a good chance at winning the comp. This combined with some knowledge of how to control a car while airborne (using the throttle and brake to adjust nose up and nose down) allowed me to win the comp. Funny then was there was also a competition for the crowd of spectators to guess how far the winning car would go and of all the hundreds of spectators my good friend Michael Cox guessed the closest!

The event was sponsored by Tamiya so we both came home with new Tamiya Hot Shot buggies. That's actually another mother face etched into my brain, that is the 2 of us loading in over \$1,000 worth of Tamiya goodies into the back of her car! I'm still not sure if Michael's mum ever really believed how he got this free buggy?

If you are new to RC Cars, I highly recommend joining a car club. Competitive racing is a ton of fun and there is lots of free knowledge to be gained, not to mention it is great to sit around between races and share stories with fellow enthusiasts.

A lot has changed over the years with the biggest changes being;

RTR (meaning Ready to Run) (screwed together)

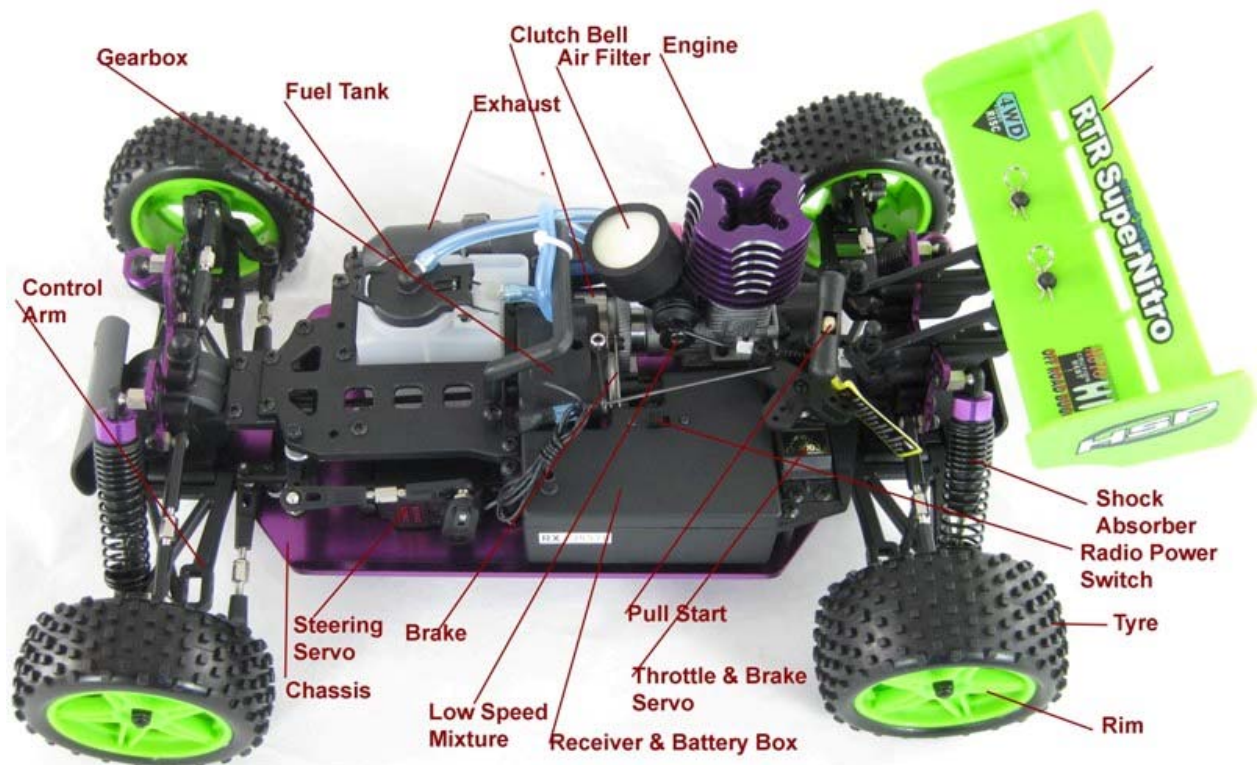
Affordability - you could not buy a radio back when I started for the price you can buy a complete car for today, never mind the engine too! An engine used to cost as much as the radio.

Ease of starting Nitro Engines: Today's nitro engines are very easy to start when you know how. I will talk a lot more about this later.

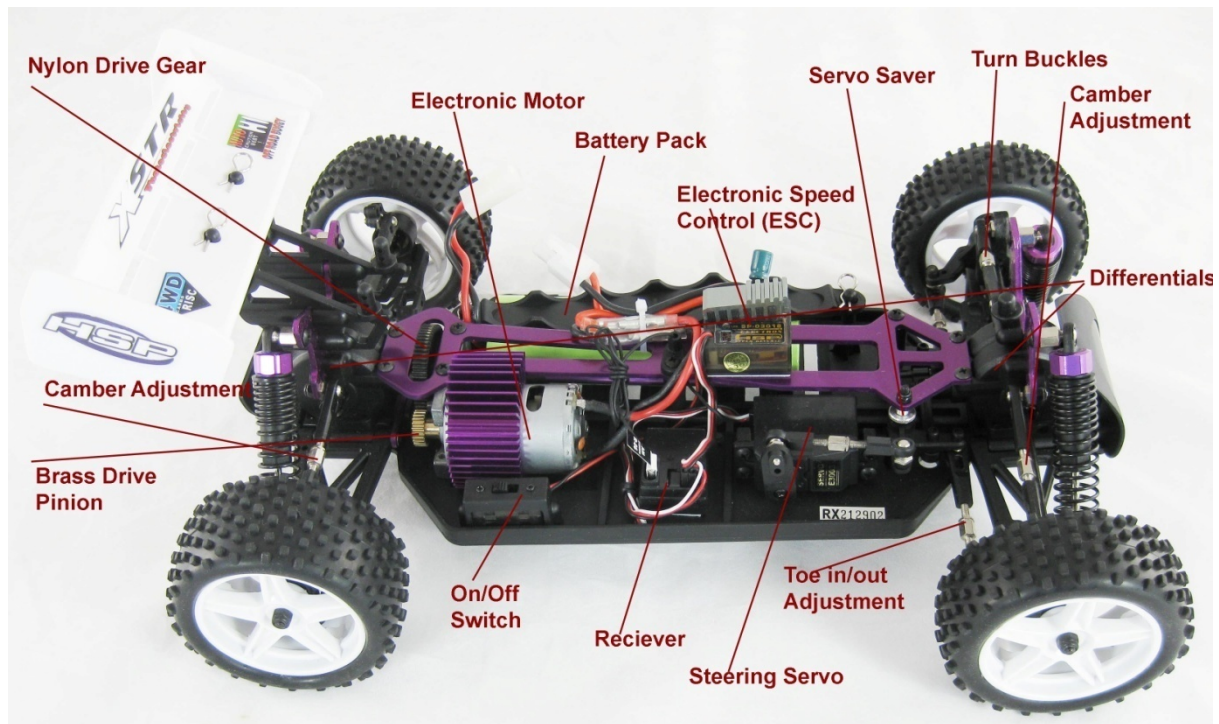
Brushless Motors: These have turned the RC World upside down. I will talk a lot more about this later too.

Li-po batteries: Like Brushless motor, these have turned the RC World upside down, I will talk a lot more about this later.

Typical Nitro powered 1/10 Scale RC Buggy



Typical Electric Powered 1/10 Scale Buggy



First Car Choice

To choose the best car to suit you, ask yourself the following questions:

On Road or Off Road?

Will you be using the car on road or off road. For off road you will need an off road model like a buggy or a truck. Road cars can only be used on smooth flat surfaces like concrete or bitumen.

Operating 2 or more cars at once?

This is easily done by using different frequency crystals in each car. These crystals are interchangeable by unplugging the transmitter crystal from the transmitter (the part you hold) and the receiver crystal from the receiver in the car.

10 plus can operate at the same time simply by using crystals on different frequencies. There are many different frequency channels. *For more information see crystals*

Rang -, how far can the car be away from the driver?

The only real way to know the range **for your car** is to test it with the engine off! On average the range for most cars is approx 100 to 200 Meters. However it can be much more or less! Always range test your car before use. *See Range Check*

Electric or Nitro?

The advantage of Electric is it much easier to use. Just charge the battery and away it goes. Nitro however is generally faster but there is a learning curve to get the car going. Once you have gone through the learning curve, it is well worth it.

In the past Nitro cars were much faster than electric but with the advent of Brushless Motors and Lithium batteries, the gap has narrowed, some even argue now brushless can be faster and more powerful. Modified Brushless cars are now getting to speeds well over 200kph (125mph). *See Brushless Motors and Lithium Polymer Batteries*

Nowadays there is often not a huge difference in performance between many brushless electric models and the nitro models, especially if you are using a 12 volt LiPo battery in the brushless electric car.



What is Nitro Fuel?

Nitro / Nitro Fuel / Glow fuel / Hobby Fuel (all generally have the same meaning in the land of RC (Radio Control)) are names used to describe the fuel used on models -- generally the same or similar fuels (Hobby Fuel) can be used in model airplanes, helicopters, cars and boats.

For the sake of this book I will just call it Nitro Fuel as this is what most modellers call it.

Nitro fuel can be burned by very simple two stroke model engines or by more complicated four stroke model engines and these engines can provide very impressive amounts of power for their very small size.

Note that the nitro name is generally inaccurate, as nitromethane is usually not the primary ingredient, and in fact many glow fuels, especially the so-called "FAI" type, named for the Fédération Aéronautique Internationale, which requires such fuel in some forms of aeromodeling competition, contain no nitromethane at all.

Glow fuel is generally a mixture of methanol, nitromethane and oil.

Methanol is usually the primary ingredient, as it provides the bulk of the fuel and is also needed as a solvent for the other ingredients. It's also needed for the glow plug generally found in model engines to burn via a catalytic reaction to keep the ignition going between strokes.

Nitromethane is generally added to the methanol to increase power and to make the engine easier to tune. Typically glow fuel is about 0-30% nitromethane, with higher percentages of nitromethane generally giving better performance but costing more (as nitromethane is considerably more expensive than methanol.) A given amount of nitromethane contains less energy than the same amount of methanol, but it requires less oxygen to burn (approximately half), so more of it can be put into an engine during each stroke and this leads to a higher power output.

For racing use, the nitromethane content can be increased well above 30% with a corresponding increase in cost, but some methanol is still required as it's needed to allow the glow plug to ignite the fuel in the first place, and as a solvent to allow the lubricants and nitromethane to mix, so the nitromethane content usually doesn't go any higher than 65%.

Nitromethane is often difficult to obtain in many countries since it is known as an explosive, so in these countries glow fuel generally has no nitromethane at all. Without at least a small amount of nitromethane, glow engines are harder to tune (get the correct fuel/air mixture) correctly and generally provide less power for a given displacement.

Most model engines require oil to be included with the fuel as a lubricant (as it's not provided by the engine itself) and so model engine fuel is typically 8-22% oil. The most commonly used lubricants are castor oil and synthetic oils, and many glow fuels include a mixture of the two. The oils included in glow fuel generally are not burned by the engine, and are expelled out the exhaust of the engine. This also helps the engine dissipate heat, as the oil emitted is generally hot.

Glow engines generally have to be run slightly rich (with a higher fuel:air ratio than is ideal) to keep the engine cool (as the fuel going out the exhaust also takes heat with it) and so vehicles with glow engines generally get coated with lots of oil (as almost all the oil comes out the exhaust) and some nitromethane and methanol as well (as it's not all burned) requiring some cleaning when one is done using their model.

Glow fuel is not difficult to make, and so many modellers mix their own to save money, but some of the ingredients are flammable and/or explosive and so can be dangerous, especially in large quantities.

Length of time per Tank or Battery Charge

Nitro Cars generally go for longer per tank however this again is rapidly changing with higher capacity batteries being continuously coming onto the market. Approx 5-10 minutes depending on how hard the car / truck is driven. With electric, many electric cars and trucks come with an 1800mah battery which lasts approx 5 minutes, again depending on how hard it is driven and the surface it is used on. On grass for instance the battery will run out earlier as grass causes a lot of resistance. Batteries with larger capacities up to 4000 + mah are

readily available and these will last approximately twice as long per charge than the 1800mah. Spare batteries vary in price from depending on the capacity. The larger the more expensive. Of course battery quality also affects the price too.

What Size / Scale

1/16 Scale is generally the smallest (that is 1/16th the size of a real car), 1/5 Scale is normally the largest with sizes in between of 1/10 and 1/8. 1/10 scale is the most popular however 1/8 is now nearly as popular.

Just remember 1/1 is a full size car. The same size as the car in your driveway!

1/2 is half the size of a full size car.

Additional items which you will need



For Nitro and Electric cars you will normally need 8 AA batteries for the transmitter. If you choose Nitro you will also need another 4 batteries for the receiver. Electric cars do not require additional batteries for the car's receiver as it derives its power from the car's main battery pack. These are just normal AA batteries which you can buy from your local supermarket or you can use rechargeable batteries.

Glow Plug Igniter (Nitro Only)



A rechargeable Glow plug igniter is required to start a Nitro Engine. Always use a rechargeable version as they give a much better glow.

Nitro Fuel



Nitro hobby fuel which is available at most hobby stores. For more information see *Nitro Fuel*

Things you must know before you start a Nitro Car

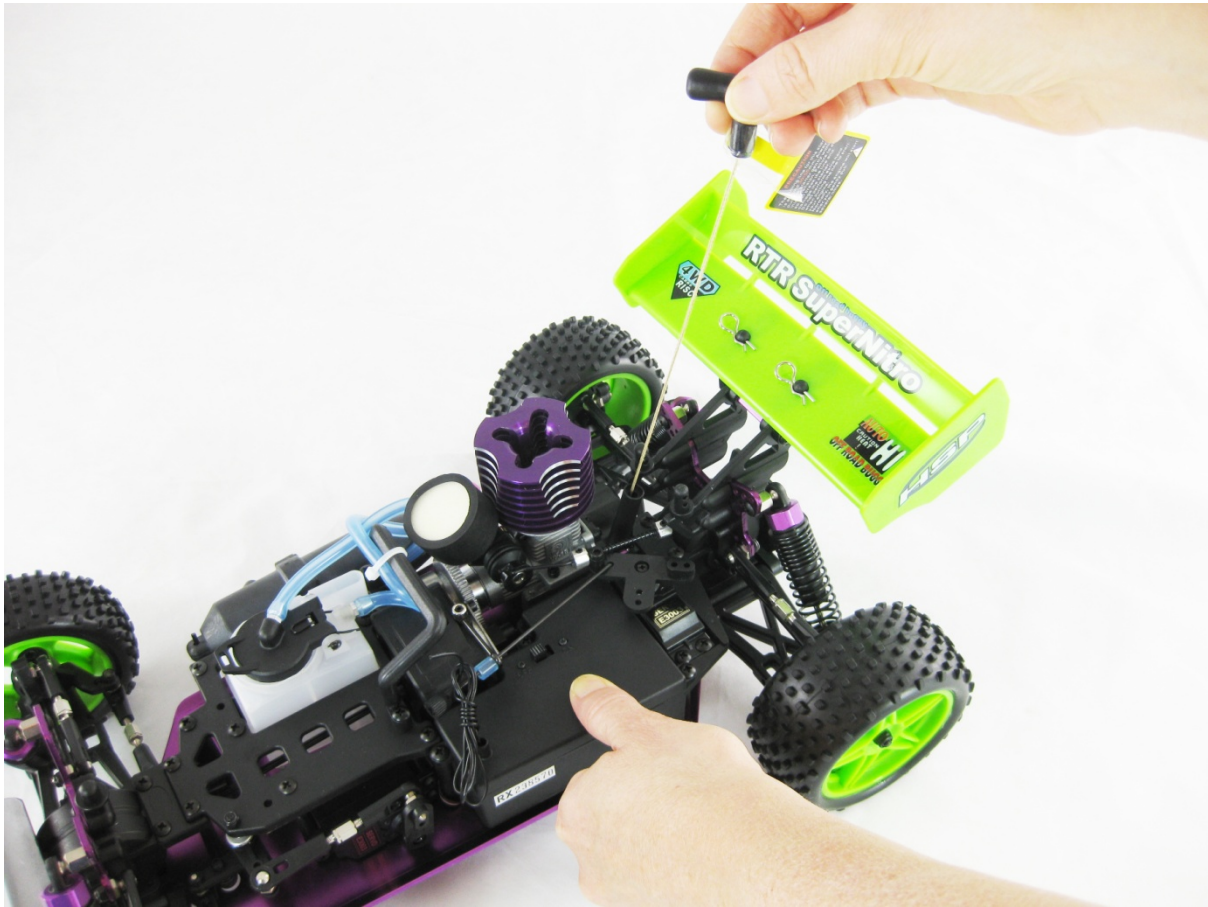


PRECAUTIONS THAT MUST BE TAKEN IN ORDER TO
COMPLY WITH MOST MANUFACTURES WARRANTIES

How to Start a Nitro Powered Engine:

[Most common mistakes made by beginners:](#)

Avoid pulling the pull starter if your engine is flooded - it will snap



1. Avoid pulling the pull starter if your engine is flooded -, it will snap. **You know your engine is flooded when the cord becomes very difficult to pull.** To get excess fuel out of the engine simply remove the glow plug and turn the car upside down. Give the pull starter a couple of pulls and excess fuel will come out.

Also, never pull the PULL START out more than 20 centimetres or it will bend the spring and/ or snap the cord.



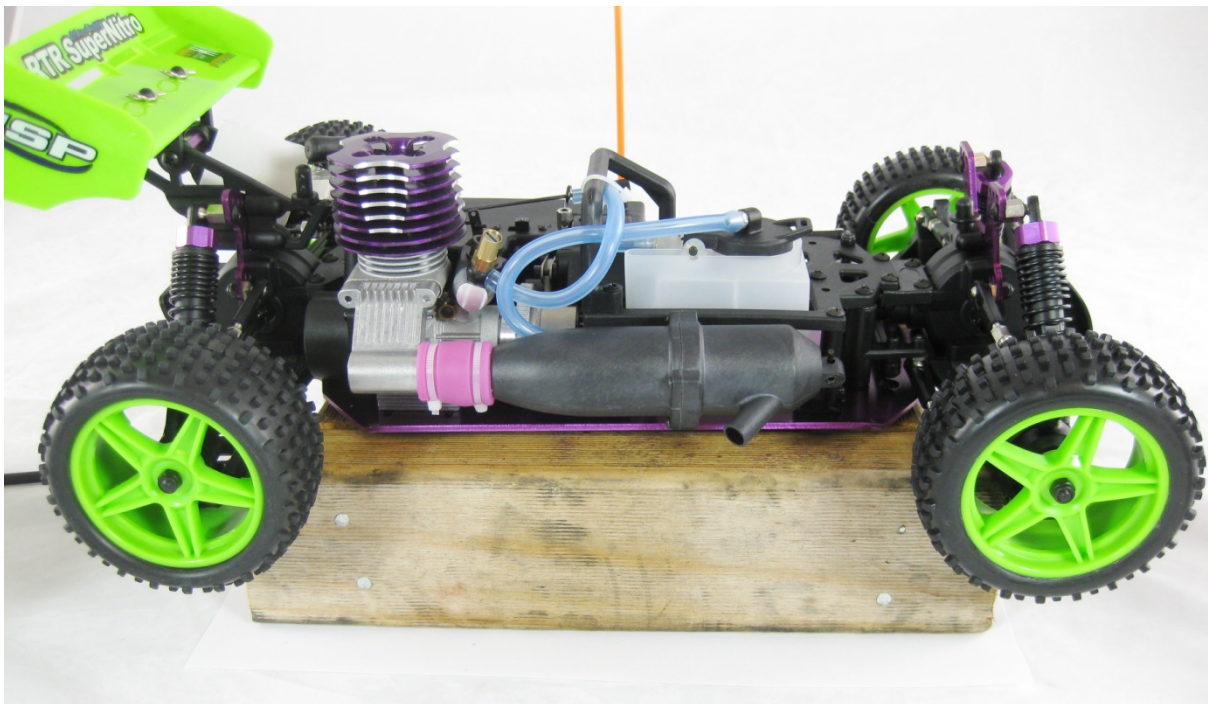
Many beginners MELT THE NYLON DRIVE GEARS

Many modern RC cars use a combination of lightweight Nylon and Aluminium gears as they do not require lubrication. This combination works very well as long as the user does not overheat the clutch.

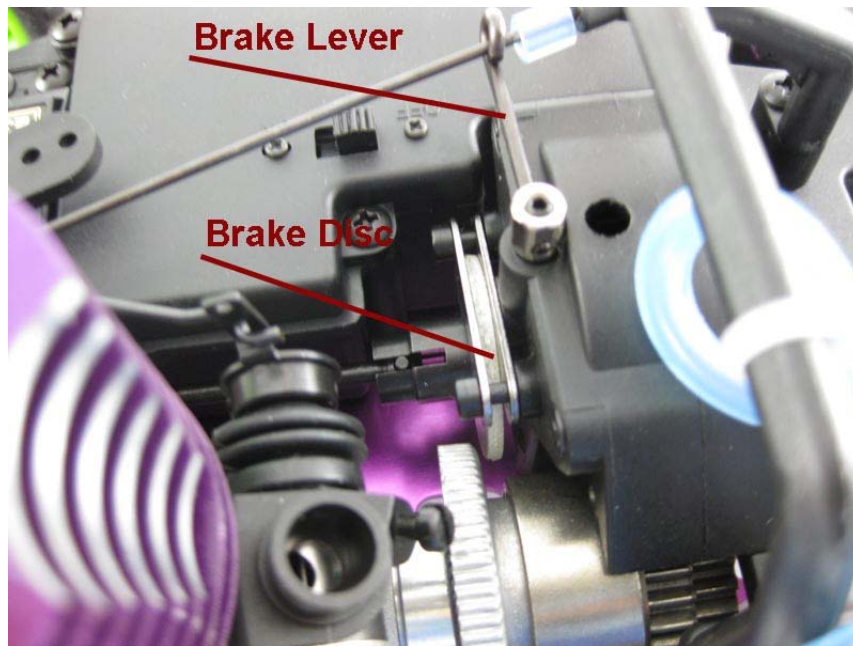
Metal on metal gearboxes needs to be fully enclosed as the gears must be greased or they will very quickly wear out. Without being fully enclosed the grease is like a magnet to the dirty environments in which RC cars operate.

Personally I prefer the Metal to Nylon combination as it is much lighter and requires almost little maintenance. HOWEVER if you restrain the wheels in any way the clutch will overheat and melt the gears. NOTE: Melted gears look like Stripped Gears.

Always start the car with the wheels OFF the ground and the brake OFF.



TO AVOID MELTING THE NYLON DRIVE GEARS You must allow the wheels to spin freely AT ALL TIMES INCLUDING when starting the engine. ALWAYS start the car with the wheels off the ground i.e. the chassis is supported by a brick or similar object AND MAKE SURE THE BRAKE IS OFF by pushing the car forward with the engine off and with the throttle trim on the transmitter set to idle position.



If you do not do this, the aluminium clutch will overheat in less than 30 seconds and it will melt the nylon drive gear(s).

Make sure that the wheels are always allowed to spin freely at all times.

[NEVER restrain the wheels](#)

NEVER restrain the wheels from spinning by restraining the car BY EITHER HAND, AN OBJECT OR WITH THE CAR'S BRAKE.

[ALWAYS check to see if the brake is off before starting the car](#)

ALWAYS check to see if the brake is off before starting the car. To test this, push the car (forward) with the engine NOT running. If the car is hard to push, the brake is on. This will cause the clutch to overheat and melt the nylon gears. Make sure the brake is off before starting the car. Beware of turning the throttle trim on the transmitter too low and accidentally putting the brake on .see transmitter

With the engine off, push the car on the ground (forward) and adjust the idle trim speed on the transmitter. Make a note of where the brake starts to engage. The carburettor should go back to idle without the brake enabling, if it doesn't, adjust the brake linkage. To see how open the carburettor is, just remove the foam air cleaner. Make sure you put the air cleaner back on before running the car. *See carburettor*

Do not replace the nylon gear with a Metal gear

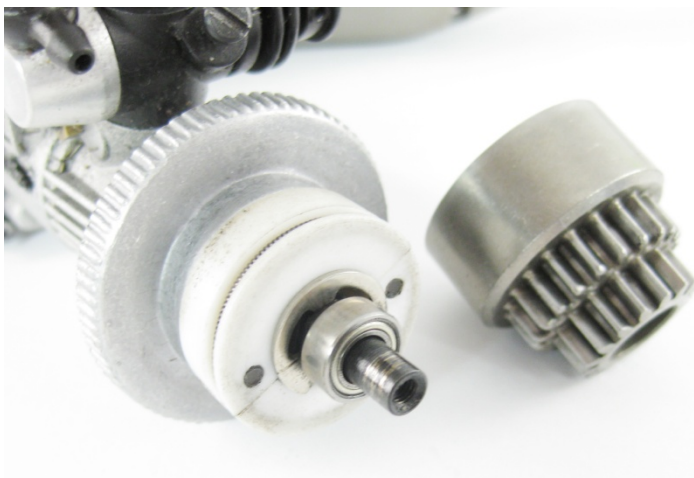
Please be very careful with this. **Do not replace the nylon gear with a metal gear** for the 3 following reasons.



1. The nylon gear will melt at approx 220 degrees Celsius and the aluminium clutch bell will disintegrate at 280 degrees, this way there is a 60 degree safety margin with the nylon gear. If the clutch disintegrates this is very dangerous as pieces fly everywhere! Under normal and race conditions the clutch bell will never normally get over 80 degrees even under the hardest of races.

2. Metal on Metal wears out very quickly when not lubricated and you cannot lubricate the gears as it would attract too much dust and dirt increasing wear even more.

3. Weight. The lighter the car, the quicker it will accelerate. Acceleration is all about power and weight. Metal gears are much heavier and are not needed.



**The clutch will only slip and therefore be susceptible to damage while the car is stationary from use of the cars brake or held stationary by hand or an object.. Once the car is up and running, the clutch is not slipping, therefore it will not sustain any damage. As long as the engine is idling at low speed, the clutch will not get too hot. Damage usually occurs when the car is idling too fast*

and the wheels are restrained or inhibited from moving in any way, this of course includes the cars disc brake.



If you leave your glow heater on your glow plug when you're not trying to start it the glow plug will burn out very quickly. Only put the heater on when you're ready to start the engine. *See glow plugs*

Make sure you unbundled the antenna wire in the car and stand it up using the supplied antenna straw.. The antenna wire may be longer than the tube, and if so, DO NOT cut the wire. Let excess wire hang freely. Be very careful not to damage the copper wire when pushing / pulling the antenna wire through the tube.

Always check screws are tight including the engines Head bolts and the glow plug. If these come loose the engine will lose compression and be hard to prime and start.

Follow the steps below to prepare, start and break-in your nitro engine.

Charge Glow Igniter



Nitro engines require a glow plug igniter to light the glow plug when starting the engine. Most igniters take approximately 10-12 hours to fully charge however See Battery charge times for more information.

You should always make sure the igniter is fully charged when starting your engine.

Make sure the glow plug igniter is not left on the glow plug too long or the glow plug will burn out. If the **engine starts but stops when the glow plug igniter is removed**, the glow plug needs replacing.

This is a weird one as if you remove the glow plug from the engine and plug it into the igniter it will still light up which makes you think the glow plug is ok however this not the case. See Glow Plugs for more information.

Install Radio Batteries



The transmitter and receiver pack (Nitro cars only) need to have batteries installed into them before doing anything else to the car. Eight batteries in the transmitter and four batteries in a nitro car are needed.

If you start the car before installing the batteries, it may run away from you. You can normally use NiMH or NiCad rechargeable batteries instead of alkaline batteries. Be sure to completely charge rechargeable batteries before installing.

Fill the tank



Make sure you are using proper high quality Hobby fuel with the correct nitro percentage (20-30% Nitro). UNLESS STATED DIFFERENTLY IN THE MANUFACTURERS MANUAL. Fuel that is left in an open bottle will go bad quickly. Always keep fuel in an airtight container.

******* WARNING***** DO NOT BEND THE FUEL LID RIGHT BACK**

If the lid is bent right back it will bend the spring in the lid and the fuel tank will not pressurize. The tank on a nitro car must pressurize from the exhaust and thus force fuel into the engine. For more information on Nitro Fuel, see Nitro Fuel

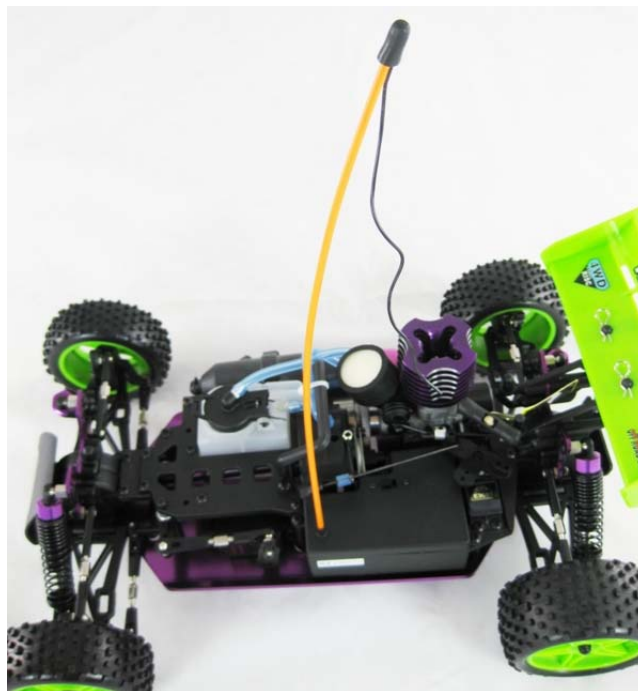
Using your fuel bottle, squeeze the bottle and insert it into your container of fuel. Let go of it and the suction will suck the fuel into your fuel bottle. Next lift the cap on the tank and fill it up with fuel.

Install your Air Filter



Some models may already have the air filter installed. If yours has not, find it in the box and install it onto the carburettor. Some come with a zip tie to use to secure it to the engine.

Standing your Antenna Up



Insert the antenna wire through the antenna mount, through the antenna tube, then insert into tube mount

Turning on your Transmitter first



ALWAYS turn on the transmitter first, followed by the receiver. Never turn off the transmitter or the receiver while the engine is running. Always turn off engine first, then the receiver, followed by the Transmitter.

Remember... You should always turn the transmitter on first and turn it off last.

[Check for Proper Operation of Servos](#)

With the transmitter and receiver all turned on (engine not running), make sure your steering, throttle and Brake servos are working correctly. Make sure when you turn the wheel on the transmitter left the wheels turn left, and then check the right side. When you

pull the throttle trigger the carburettor Venturi should open.



When you push the trigger back the brakes should be applied. If your servos are moving / responding slowly, you need to check for weak batteries.

Range Check - Checking the Radio's Range

Always perform a range check before driving your car. This tests the range of the radio detects any radio interference. To do a range check do either of the following.

1. Walk away from the car to equal the furthest distance you plan to drive your car with the transmitter and cars aerials fully extended or;



2. With the models aerial fully extended and the transmitter aerial **fully DOWN**, walk away 5 metres from the model.

In either of these range checks, make sure all the servos operate correctly. Do not operate the car if you notice any radio problems or interference,

Every RC Car, Boat, Plane, Helicopter manufacturer will not cover warranty repairs from radio failure as it is impossible to know whether a model crashed due to radio failure, radio interference, low batteries, battery failure from vibration, transmitter aerial not screwed in correctly, transmitter aerial over tightened damaging connection inside transmitter or operator error. Therefore, it is critical to always do a range check before operating any RC model.

Radio Interference can be caused for many reasons. Some of these include another models transmitter on a similar frequency, a 2 way radio i.e CB, Fire Brigade, Police etc, power lines, geographic Interference etc etc. Always do a range check before operating the model. If you get interference, either move to different area or wait until it stops.

Always be very careful not to let the batteries get low, as this can cause the servos to start vibrating and will give a substantial reduction in range. In our race cars we always use Rechargeable batteries as they can output much more power than a conventional Alkaline battery making the servos operate much faster. Alkaline will last much longer as they have a very low power output however they are not yet powerful giving sluggish response from the servos.

Rechargeable and conventional batteries can be purchased from supermarkets like Woolworths.

If your area is subject to radio interference then I would highly recommend you install a failsafe. These low cost items return the throttle back to idle if the radio has any interference or loss of signal.



Prime the Engine with Fuel

To prime the fuel system, put your finger over the exhaust outlet on the exhaust pipe. Pull the pull cord a few times and watch for the fuel to fill the fuel line. Normally pull 1-3 times more once the fuel reaches the carburettor. Any more can flood the engine. Cold engines require more priming than a hot engine.

If you notice the fuel line is not priming, you may need to open the carburettor to allow the fuel to flow through. If it is still not priming *see trouble shooting*



Starting a Nitro Engine

Do not start the engine until you have read and understood all the directions. By starting the engine you have indicated that you have checked the transmitter and servos for proper operation and completed the range check.

Turn both the transmitter and receiver on and make sure both aerials fully extended.

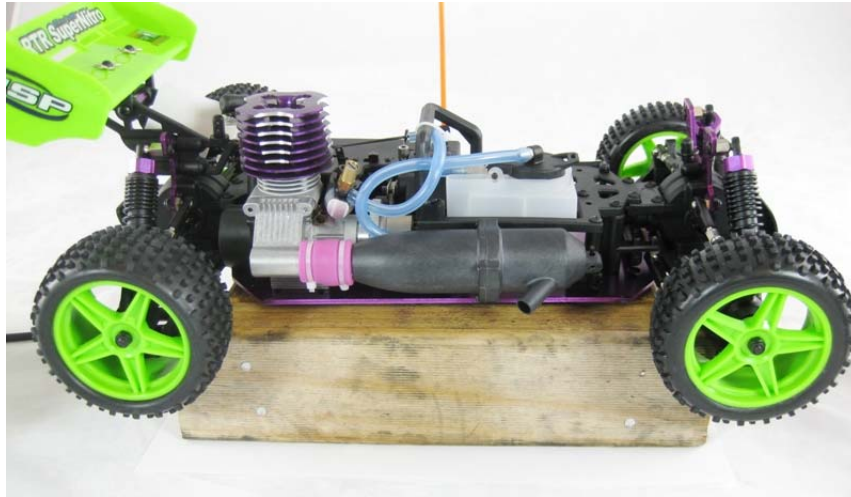
Turn the throttle trim knob on your transmitter until the venturi is open approximately 1/4 to 1/8th of the way. In other words nearly closed.



Attach your fully charged glow igniter onto the glow plug. With one hand holding the car, use your other hand to give the pull starter quick short pulls. **(Pulling the Pull start cord more than 20 centimetres will brake the spring inside).**



Always ensure that the car is held off the ground so that the wheels can spin freely. Otherwise the clutch will overheat and melt the nylon gear. Beginners often hold the car on the ground at medium to high revs causing the clutch to very quickly overheat.



If the engine does not start prime and then try again.

If it still does not start *see troubleshooting*

Step 12 Keep the Engine Running

A new engine may not idle smoothly until it's correctly broken in and the mixture set correctly. See *Break in Procedures*. Use the transmitters throttle trim to keep the engine revved up just enough to keep it running. If the engine stalls you may need to raise the idle slightly.



Proper Engine break-in

Proper engine break-in is very important to achieve the highest possible performance and reliability

Allow yourself some time to properly break-in the engine. This is one of the most important steps to follow so take your time. Do not run the engine at high RPMs until it is completely broken in. It is usual for the engine to stall, run inconsistently, and even foul glow plugs during the first couple of

tanks. If this is happening to yours, don't worry about it too much. It is a normal step in running any nitro powered R/C car. All of this will go away after your engine is broken in and the mixtures set correctly.

Break-in Procedures

To begin break in procedures for your new engine, simply idle 3 tanks of fuel. ENSURE IT IDLES WITH THE WHEELS OFF THE GROUND AND THE BRAKE OFF SO THAT THE CLUTCH DOES NOT OVERHEAT. Allow the engine to cool down completely between tanks. **After the 1st tank of fuel, check all the screws to make sure they are tight. Nitro Cars, Planes, Boats, Helicopters etc vibrate a lot and nuts and bolts will come loose due to the vibration of the Nitro Engine.** It is also a good idea to use Loctite (available at hardware stores)



Loctite is like a soft glue which helps keep nuts and bolts tight. Make it a regular habit to continuously check all the nuts and bolts. We always go over our race cars after every race.

After the third tank, check the gap between the metal clutch gear and the nylon drive gear. This gap will widen as the car is run in. There should only be enough gap to accept 1-2 thin pieces of paper between the 2 gears. If the gap is larger, undo the 4 motor mount screws under the car and slide the engine closer.

An easy way to get the gap perfectly correct is to slide 1-2 pieces of thin paper between the gears and then push the metal clutch bell onto the nylon gear with the paper in between the gears. To get the paper in, just push the car backwards and feed the paper in between the 2 gears.

On the 4th and 5th tank start driving the car around slowly. On the 6th tank start leaning it out and making final tuning adjustments.

Break in Mixture Settings:

Most engines come pre-set from the factory for the average day's atmospheric conditions so you usually do not need to change the mixture settings for break in. i.e. 15 degrees Celsius, 1013 hectopascals barometric pressure etc. This will be ok most of the time for breaking however you may need to adjust the mixture if your day's conditions are a lot different. *See mixture settings*



When you do change the mixture settings, RECORD THE FACTORY SETTINGS.

To record the factory settings, wind the low and high speed mixture screws all the way in until they stop and COUNT the turns as you are winding them. After you have recorded the turns, record them and wind them back out to default.

An example of one type of an engine is as follows:

Typical Factory Setting:

High Speed Mixture: 2 1/2 turns out

Low Speed Mixture: 4 turns out

After Break in:

Top: 3 turns out

Bottom: 4 1/2 turns in turns out

* These settings are approximate due to the differences in climate, fuel nitro %, and fuel oil %.

Running the First Tanks in the Car

By now you should have fully broken in your engine. Hopefully you took your time and broke the engine in correctly. When driving the car, drive it on flat smooth surfaces like the street first. Make sure that your steering trim is adjusted correctly and that the car tracks straight.

Engine tuning (adjusting the high-end needle)



Now your car and engine should be up and running well. The overall performance of the engine is largely determined by how you tune the mixture. The "leaner" the engine to a point, the faster it will go and the hotter it will run. Too lean will damage the engine.

You want to find the point where it's running very well then with lots of power, then wind the high speed mixture out just a fraction.

If you don't see a light stream of blue smoke from the exhaust it may be too lean. You then need to make the high speed mixture richer. (Screw with brass sleeve around it). All of the engine adjustments listed above are not exact because of variations in type of fuel, brand, %nitro, humidity, elevation, etc.

Engine life varies on the operating temperature. Preferred engine temperature is around 104-115 Degrees Celsius or 220-240 Degrees Fahrenheit.

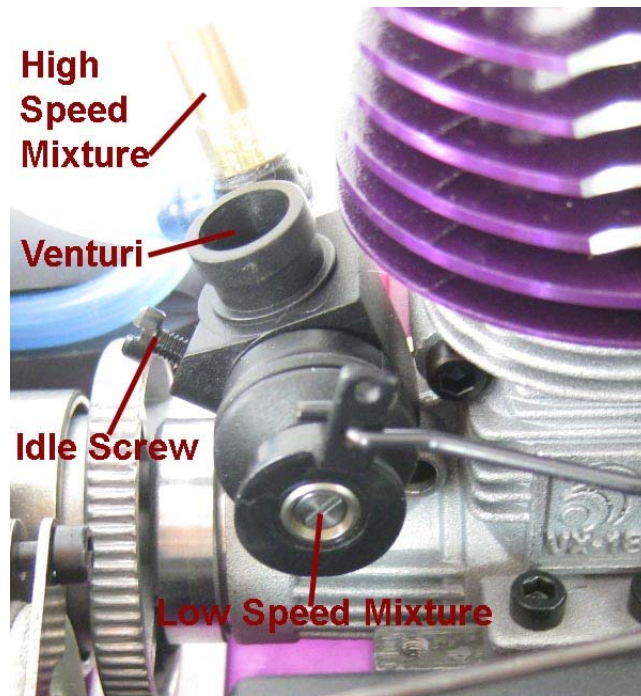
Typical Engine Temperature gauge.



Fine Tuning low-speed Mixture and Idle screw.

The best way to check the low speed adjustment is by listening to the way the engine revs from idle. If the engine splutters it is too rich

If the engine tries to cut out it is too lean. When making any needle adjustments make sure you do it in small adjustments.



Installing the Body Clips

Align the holes in the body with the body mounts. Then install the pins through the holes in the mounts. You may adjust the height of the body by lowering body clips.



How to Stop The Engine.

To stop the engine, either block the air cleaner with your fingers or squeeze the fuel line to the carburettor. Either method will stop the engine. Squeezing the fuel line will make the engine speed up first as the engine leans out.

If you squeeze the fuel line, make sure you squeeze the pipe going to the engine.

This is the most important step of all

Drive your new nitro powered RC car! Have fun and drive safely. Show your model the same respect as you would driving your full size vehicle. Or if you don't show your own vehicle any respect then pretend it's your parents' car! :0

Steps to follow after operating.

See also Maintenance

Step 1. Empty all of the fuel out of the tank.

Step 2. Burn all the fuel out of the engine by keeping the engine running until the engine will not start.

Step 3. Take the glow plug out and put a few drops of after run oil into the engine. After run oil is available at most hobby shops.



Precautions That Must be Taken

- Because there are electrical components on the car it should not be run through water, wet grass, mud or anything else that may get water inside the electronics.
- Avoid leaving the glow heater on the glow plug any longer then needed to start. The heater will burn the glow plug out if left on too long.

- Do not drive the car when your radio is showing low battery voltage.
- Do not drive your car at night, on public streets, or in large crowds.
- Do not drive if the servos are slow or unresponsive, this usually means your batteries are low, replace with new ones.
- Always use common sense when driving your RC car. Abusive driving will only result in poor performance and many broken parts.

General information

High-end Mixture Controls the fuel mixture at high R.P.Ms

Low-End Mixture Controls the fuel mixture at low R.P.M.s

Lean - This term is used to describe the amount of fuel entering the carburettor. Lean means less fuel. Turn carburettor needles clockwise for a leaner setting. Running too lean will damage your engine.

Rich Setting - This term is used to describe the amount of fuel entering the carburettor. Rich means more fuel. Turn the carburettor needles counter-clockwise for a richer setting.

Glow plugs - nitro engines come standard with a glow plug. Check with the engine manufacture for which type of glow plug to use. . Always make sure you are using the copper washer that is supplied with each glow plug. For more information see *Glow Plugs*

Air Filter - The air filter is very important to an engines life. Keeping it clean and oiled will increase performance and engine life.

Pull Starter - When removing the pull starter be careful with the spool, which is spring loaded. Use a small screwdriver to gently push the spool off the output shaft.

...and have fun!

Don't despair if your car loses an argument with a tree. Most RC Cars have an index of part numbers in the back of the manual. You can literally build a whole car out of the spare parts so rest assured it does not matter bigger crash you have, you can replace any broken part. Most shops these days have an online store, just type the part number out of your manual into their search box and the part should come up.



Things you need to know about Electric RC Cars

PRECAUTIONS THAT MUST BE TAKEN IN ORDER TO COMPLY WITH MANUFACTURERS' WARRANTIES.

Follow the steps below to prepare and run your car.

Most common mistakes made by beginners:

Most beginners do not regularly check the nuts and bolts for tightness, especially the engine bolts. Go over the whole car to make sure every nut and bolt is tight.

INSTRUCTIONS FOR USE:

CHARGE MAIN BATTERY



In regard to charge times for the battery; to do this use the following formula:

As an example and to keep the maths easy, I will use an example of a 1000mah battery and a 100mah charger. Just replace these numbers with the numbers written on your battery and charger.

In a perfect world where there was no loss (heat) you would just charge the battery for 10 hours (1000 divided by 100) however there are losses in charging of around 30% so in this example you would need to charge the battery for 10 hours x 1.3 to compensate for the losses equalling 13 hours.

This of course is only when the battery is dead flat.

For the rest of the time just charge the battery until it gets warm (not hot). Once the battery starts getting warm it is fully charged.

Just be careful not to overcharge the battery as it will damage the battery.

On many mains powered chargers, the light on the charger does not go off when the battery is charged – it lights up to show that the battery is connected.

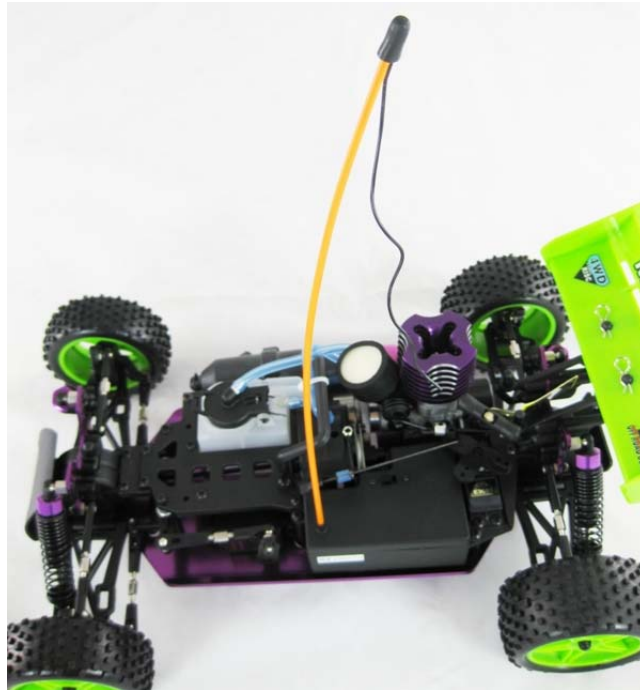
Install 8 X AA Batteries in the Transmitter

Most transmitters need to have 8 x AA batteries installed. If you turn the car on before switching on the transmitter, it may run away from you. Most transmitters allow you to use NiMh or NiCad instead of alkaline batteries. Be sure to completely charge rechargeable batteries before installing.



STANDING YOUR ANTENNA UP

Insert the antenna wire through the antenna mount of the car, through the antenna tube, then insert into tube mount. The antenna wire may be longer than the tubes, if so, DO NOT cut the wire. Let excess wire hang freely.



TURNING ON YOUR TRANSMITTER

ALWAYS turn the transmitter first, followed by the receiver.

*** Remember.... You should always turn the transmitter on FIRST and turn it off LAST.



CHECK FOR PROPER OPERATION OF SERVOS

With the transmitter and receiver all turned on and with the car on a block with the wheels off the ground, make sure your steering, throttle and forward/reverse are working correctly. Make sure when you turn the wheel on the transmitter left, the wheels turn left, and then check the right side. When you pull the throttle trigger the wheels should turn forward and when you push the trigger back the brakes should be applied. If you push the trigger a second time the car should go in reverse.

RANGE CHECK - CHECKING THE TRANSMITTER RANGE

Before driving your car, always test the range, and or any radio interference of your radio system. To do a range check, do either of the following:



1. walk away from the car to equal the furthest distance you plan to drive your car with the transmitter and cars aerials fully extended, or:
2. With the models aerial fully extended and the transmitter aerial fully DOWN, walk away 5 metres from the model.

In either of these range checks, make sure all the servos operate correctly. Do not operate the car if you notice any radio problems or interference.

Every RC car, Boat, Plane & Helicopter manufacturer will not cover warranty repairs from radio failure as it is impossible to know whether a model crashed due to:

Radio failure

Radio interference

Low batteries

Battery failure from vibration

Transmitter aerial not screwed in correctly.

Transmitter aerial over tightened damaging connection inside transmitter OR

Operator error

Therefore, it is critical to always do a range check BEFORE operating any RC model.

Radio interference can be caused for many reasons. Some of these include other models transmitters on a similar frequency, a 2 way radio ie CB, Fire Brigade, Police etc, power lines, geographic interference etc... etc.. Always do a range check before operating the model. If you get interference, either move to a different area or wait until it stops.

Always be very careful not to let the batteries get low, this will cause the servos to start vibrating and will give a substantial reduction in range. In our race cars we always use Rechargeable batteries as they can output much more power than a conventional alkaline battery making the servos operate much faster. Alkaline will last much longer as they have a very low power output.

Rechargeable and conventional batteries can be purchased from supermarkets.

Always ensure that the car is held off the ground so that the wheels can spin freely when first switching the car on.

BREAK-IN PROCEDURES

To begin break in procedures for your new engine, simply run 3 battery packs. Allow the engine to cool down completely between batteries. **After the 1st run, check all the screws to make sure they are tight, especially the engine bolts. Model cars, planes, boats, helicopters etc... vibrate a lot and nuts and bolts will come loose due to the vibration.** It is also a good idea to use Lock tight (available at hardware stores) Lock tight is like soft glue which helps keep nuts and bolts tight. Make it a regular habit to continuously check all the nuts and bolts. We always go over our race cars after every race.



After the 3rd battery pack, check the gap between the brass engine pinion and the nylon drive gear. This gap will widen as the car is run in. There should only be enough gap to accept a thin piece of paper between the 2 gears. If the gap is larger, undo the 2 motor mounts screws and slide the engine closer.

An easy way to get the gap perfectly correct is to slide 1 piece of paper between the gears and then push the nylon drive onto the brass pinion gear with the paper in between the gears. To get the paper in, just push the car backwards and feed the paper in between the 2 gears.

INSTALLING THE BODY CLIPS

Align the holes in the body with the body mounts. Then install the pins through the holes in the mounts. You may adjust the height of the body by lowering the body clips.



THIS IS THE MOST IMPORTANT STEP OF ALL!

Drive your RC car!! Have fun and drive safely. Show your model the same respect as you would driving your full size vehicle. Or if you don't show your own vehicle any respect, then pretend that it's your parents car! :0

PRECAUTIONS THAT MUST BE TAKEN

- Because there are electrical components on the car, it should not be run through water, wet grass, mud or anything else that may get water inside the electronics.
- Do not drive the car when your radio is showing low battery voltage.
- Do not drive your car at night, on public streets, or in large crowds.
- Do not drive if the servos are slow or unresponsive, this usually means your batteries are low, replace with new ones.
- Always use common sense when driving your RC car. Abusive driving will only result in poor performance and many broken parts.

Don't despair if your car loses an argument with a tree. Most RC Cars have an index of part numbers in the back of the manual. You can literally build a whole car out of the spare parts so rest assured it does not matter bigger crash you have, you can replace any broken part. Most shops these days

2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 2681, 26

Alkaline type of battery. Alkaline batteries are renowned for long life however their power output is very low making steering etc sluggish.

The other great reason to use re-chargeable batteries is they are much more economical, just charge them up rather than fork out another \$10-15 dollars for another set of Alkaline Batteries.

You will of course need a charger as well. *See Battery Chargers*

Rechargeable batteries are available at places electrical shops and these days even supermarkets!

Generally the more capacity the batteries have, the more they cost. Any battery with a capacity greater than 1000mah is fine however 2000mah will last twice as long.

Batteries for Electric RC Cars



A standard 7.2v RC Electric car battery pack has a measurement of 130mm x 45mm

The MAH indicates the capacity of the battery.

The time a battery will last can varies between 5 -10 minutes per 1800mah battery. The times depend on how it is driven and the surface it is driven on and of course how much power your car's engine uses. Flat hard surfaces like bitumen create the least friction whereas long grass creates the most.

Most RC cars are designed to last for the international standard for electric car racing, that is races are usually held for a 5 minute duration.

You can increase the times by using a battery with a higher capacity. Batteries come with a capacity up to 5000mah however around the 4000mah is the most economical today.

Most Electric RC Cars come with a battery which meets the following criteria;

Voltage: 7.2 Volts

Capacity: 1800mah or greater

These are normally assembled out of 6 X 1.2 Volt cells

All NiMH (Nickel Metal Hydride) batteries are 1.2 volts. To get 7.2 volts the manufactures just solder 6 together.

BATTERY CHARGE TIMES

In regard to charge times for the battery, to do this use the following formula.

As an example and to keep the maths easy, I will use an example of a 1000mah battery and a 100mah charger. Just replace these numbers with the numbers written on your battery and charger.

In a perfect world where there was no loss (heat) you would just charge the battery for 10 hours (1000 divided by 100) however there are losses in charging of around 20% so in this example you would need to charge the battery for 10 hours x 1.3 for the losses = 13 hours.

This of course is only when the battery is dead flat.

For the rest of the time just charge the battery until it gets warm (not hot). Once the battery starts getting warm it is fully charged.

Just be careful not to overcharge the battery as it will damage the battery.

The light on the many chargers does not go off when the battery is charged - it lights up to show that the battery is connected.

Can I use a higher voltage battery?

You need to check with the Manufacture of the car to see if the ESC and motor can handle the higher voltage

Lithium Polymer Batteries – LiPO

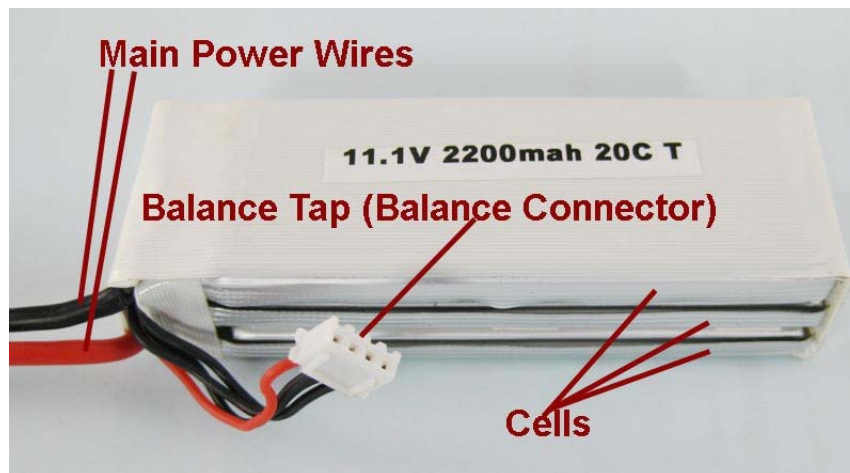


Lithium Polymer batteries are similar to Lithium Ion batteries in that they each have a nominal voltage of 3.6 volts, but dissimilar in that they do not have a hard metal casing but rather a flexible material encloses the chemicals inside. Most lithium polymer batteries are thin rectangle shapes with two tabs on the top one positive one negative. The reason we use Lithium cells for RC is that they are much lighter than comparable NiCad or NiMH batteries.

Voltage and Cell Count:

Ni-Mh battery packs are all constructed out of 1.2 volt cells i.e a 7.2 volt battery pack is constructed from six 1.2volt cells all joined together.

All Lithium batteries are constructed from 3.6 volt cells



LiPolys act differently than NiCad or NiMH batteries do when charging and discharging. Lithium batteries are fully charged when each cell has a voltage of 4.2 volts. They are fully discharged when each cell has a voltage of 3.0 volts. It is important not to exceed both the high voltage of 4.2 volts and the low voltage of 3.0 volts. Exceeding these limits will harm the battery.

You will know when driving that it is time to stop when you experience a sudden drop in power. Unlike NiCad or NiMH batteries, Lithium batteries have a very linear discharge rate then a very sudden drop in power. As soon as the battery drops in power you must IMMEDIATELY stop the car.

If your ESC has an automatic lithium mode. Use it, it will correctly sense the number of cells and set the auto cut-off appropriately.

WARNING – YOU MUST READ BEFORE USING A LITHIUM BATTERY

Li-Po batteries give a very linear power output when the voltage drops, it drops very quickly. As soon as the voltage drops you must immediately stop using the engine

Lithium batteries are quickly becoming the preferred power sources for most electric modellers today. They offer high discharge rates and a high energy storage/weight ratio. However, using them properly and charging them correctly is no simple matter.

1. Charging/Safety VERY IMPORTANT!

Until you are willing to follow all safety precautions, DO NOT use lithium batteries. If you're the type of person that prefers to push the limits of products, or be haphazard about safety requirements then Lithium technology is not for you. Read on to find out why.

Lithium cells must be charged very differently from NiCad or NiMH. They require a charger specifically designed to charge lithium cells. Using a Nicad or NiMH charger will almost certainly guarantee a very dangerous fire. Most chargers which can charge lithium ion can also charge lithium polymer, assuming that the cell count is correct..

Charging cells is the most hazardous part of using lithium batteries. EXTREME care must be taken when charging them. It is important to set your charger to the correct voltage or cell count. Failure to do this can cause the battery to spew violent flames.

There have been many fires caused by lithium batteries. PLEASE BE RESPONSIBLE when charging lithium batteries.

The Li-Po charger MUST be approved for lithium batteries. The charger may be designed for Li-Ion or Li-Poly. Both batteries are charged in exactly the same.

Make certain that the correct cell count is set on your charger. If your charger is digital watch the chargers screen very closely for the first few minutes to ensure that the correct cell count continues to be displayed.

Use the Balancing Taps (the white plug). Before you charge a new Lithium pack, check the voltage of each cell individually. Then do this after every tenth charge

This is absolutely critical in that an unbalanced pack can explode while charging even if the correct cell count is chosen. If the cells are not within 0.1 volts of each other then charge each cell individually to 4.2 volts so that they are all equal. If after every discharge the pack is unbalanced you have a faulty cell and that pack must be replaced.

NEVER charge the batteries unattended. This is the number one reason for houses and cars being burned to a crisp by lithium fires.

5. Use a safe surface to charge your batteries on so that if they burst into flame no damage will occur. Bear in mind when they catch on fire the flames do 4 foot + 1 in the air. I use a metal toolbox with holes drilled in it however other ideas are Lipo Sacks, vented fire safes, porcelain dishes with sand in the bottom, fireplaces, plantpots with soil in them etc

DO NOT CHARGE AT MORE THAN 1C unless specifically authorized by the pack vendor. This means if the battery has a capacity of say 2000mah, do not charge it faster than 2 amps.

DO NOT puncture the cell. If a cell balloons quickly place it in a fire safe place, especially if you were charging it when it ballooned. I have had a cell catch fire 20 minutes after it was disconnected from the charger.

Always let a ballooned cell sit in the fire safe place for at least 2 hours.

I always keep a bucket of sand nearby so if a battery does catch on fire I can quickly extinguish it with the sand.

C is how long it takes to discharge

A Lipo batteries discharge ability is rated in C's . C is how long it takes to discharge the battery. For instance 1 C discharges the battery in 1 hour. 2 C discharges the battery in ½ or half an hour.

All batteries holding capacities are rated in milli Amp hours (MaH). If a battery is holds 2000 mAh and you discharge it at 2000mA (2 amps) it will be completely discharged in one hour.

All batteries have limitations on how fast they can discharge. It is worth learning something about Watts, Volts, and Amps. Understanding these concepts is beyond the scope of this book.

Battery Temperature.

Lithium batteries like heat, but not too much. In the winter time, try to keep your batteries from the cold as much as possible. At the same time don't let them heat up too much. Try to keep your batteries from reaching 70 degrees Celsius after use. This will prolong the life of the cells. A good way to measure temperature is a handheld Infrared Temperature guage



Battery Connectors

There 2 commonly used battery connectors. The white plug = Tamiya plug and the red Deans Plug.

My advice is simple. Cut the Tamiya plug off and solder the Deans plug on.

Back in 1980 the Tamiya plugs were fine however today engines pull much more power. Don't even think about a Tamiya plug with a brushless motor.



Red plug = Deans

White plug is the Tamiya plug



i.e low cost mains powered battery charger with no auto cut off.

These normally output around 150mah and take approximately 17 hours to charge a 2000mah battery.

These chargers are good for battery however bad for dad listening to nagging son!

The chargers generally do not automatically turn off.

I have 12 off these chargers plugged into 2 power boards and use these chargers to charge up 12 batteries slowly before race day and then use a fast charger at the race track.

Fast Charger



These can normally output up to 5 amps (5000mah) and take approximately 30 mins to charge a 2000mah battery. They also normally have an auto cut off when the battery is fully charged.

Bad for battery however good for Car owner!

Most good fast chargers have “Peak Detect” which automatically detects when the battery is full and shuts down.

Lithium Chargers

I have made a separate category for Lithium chargers more just to spell out you need a totally different kind of charger to charge a Lithium Polymer battery however many new chargers do support Lithium batteries. HOWEVER you must tell the charger you are using a Lithium battery.

Most Lipo chargers take 30 – 60 mins to charge a Lipo battery.

Field chargers

Field chargers are a lot more beneficial as you can charge batteries when you're out and about instead of having to go home to charge.

You simply clip the alligator clips to any 12 volt battery to charge, e.g. your full size car's battery.

This is by far the preferred type of charger for modellers.

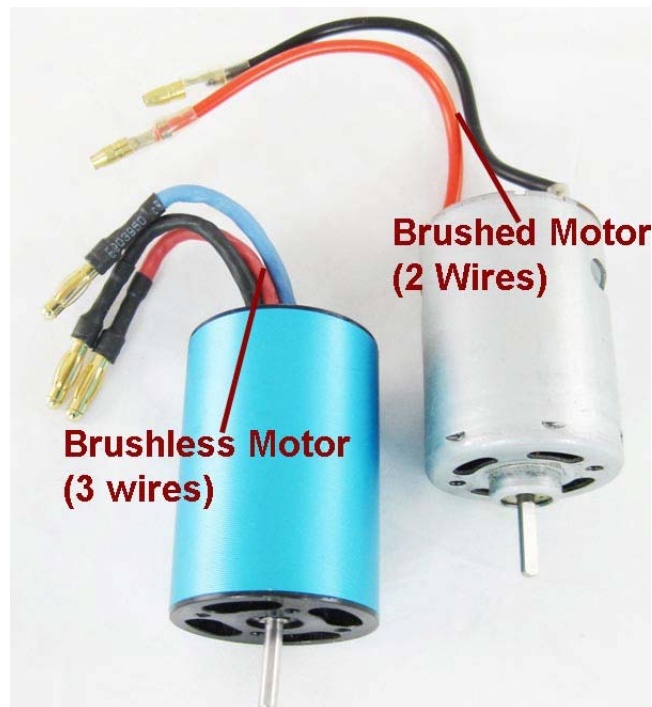
Most Serious Electric RC modellers have a powerful 12 volt power supply at home and then attach the 12 volt field chargers to it. See the picture of my charging station above.



ENGINES

Electric Motors

Brushless Motors



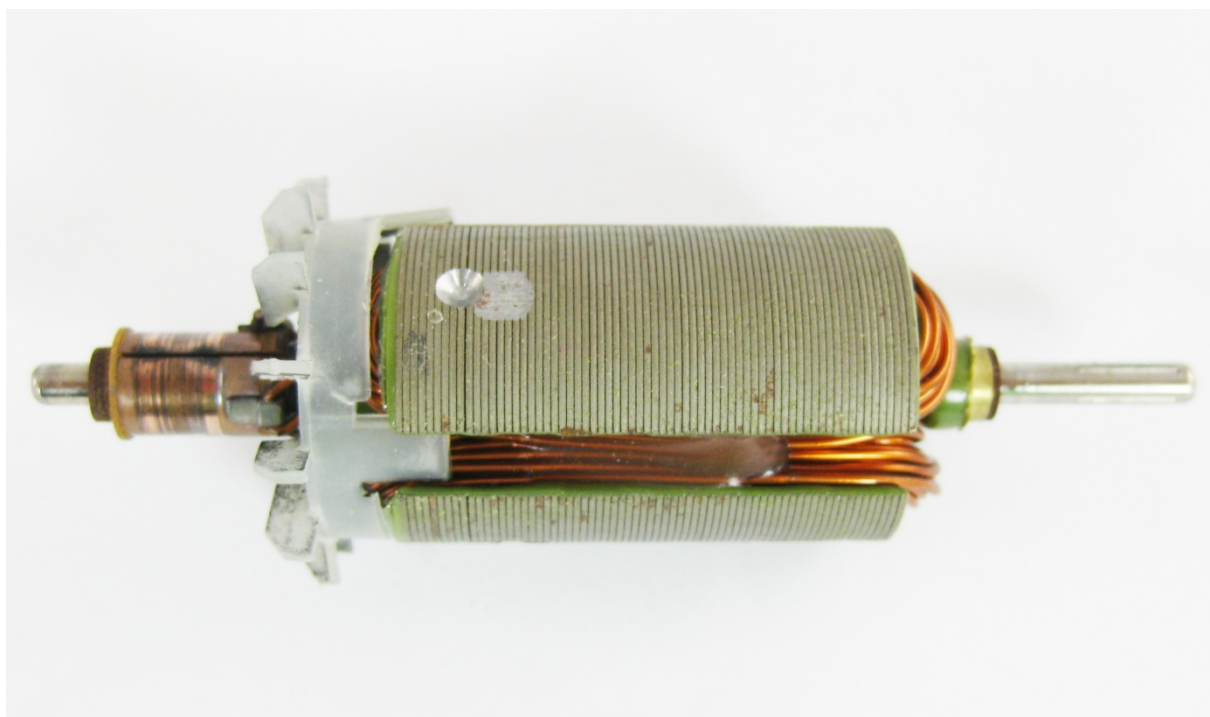
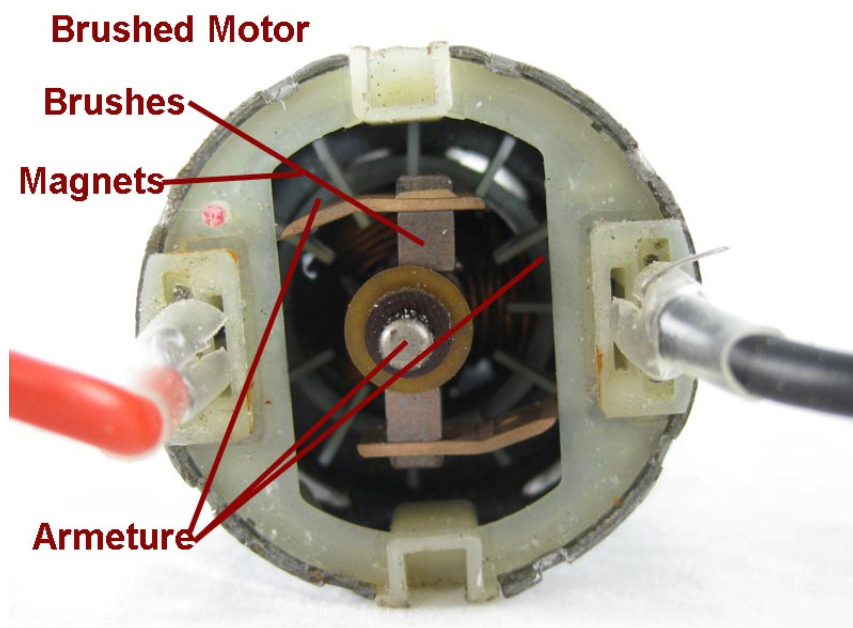
A brushless motor uses 3 wires and no friction generating brushes. A brushless motor is normally around 98% efficient compared to less than 50% efficiency for the older brushed motors.

This means longer battery life and more power.

A brushless motor also requires a brushless Electronic Speed Controller; it will not work with a brushed ESC. *See Electronic Speed Controllers*

How does a Brushless Motor Work

A traditional Brushed motor has magnets on the outside and a spinning armature on the inside. The magnets are fixed and subsequently called the stator. The armature rotates, so it is subsequently called the rotor.



Armature (Rotor)

The armature above becomes an electromagnet when electricity flows through it.

As the armature spins, it is attracted then repelled from the magnets in the stator.

The brushes rub on the end of the armature to provide the electricity.

This tried and proven technology works and is simple and cheap to manufacture, but it has a lot of problems:

The brushes wear out.

Because the brushes are making/breaking connections, you get sparking and electrical noise.

The connecting ability of the brushes limits the maximum speed of the motor.

Having the big electromagnet in the centre of the motor makes it harder to cool.

The use of brushes puts a limit on how many poles the armature can have.

With Brushless motors the magnets and stator are in reverse so there is no need to electrify the rotor as the rotor just contains the permanent magnets.



Brushless Motor

The Electro magnets are now on the stator and are connected Brushless Electronic Speed Control (ESC) which has high-power transistors to charge up the electromagnets as the shaft turns. This system has many advantages

Because the ESC (Electronic Speed Control) controls the motor instead of mechanical brushes rubbing on the rotor it is much more efficient. Most brushless motors are 98%+ efficient compared to 48% for the older style brushed motors.

Efficiency means more power, more speed, more battery life.

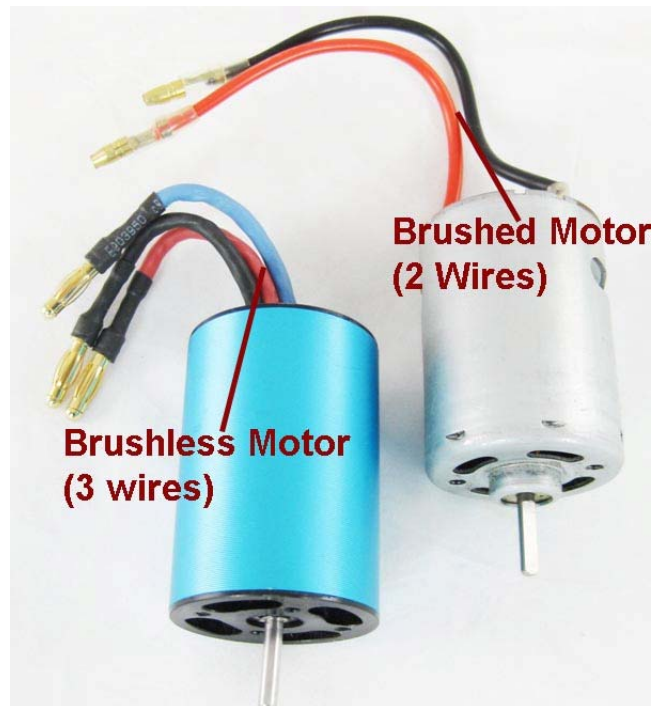
Other advantages are;

There is also no sparking from the brushes making much less electrical noise.

With the electromagnets on the stator, they are very easier to cool.

You can have a lot of electromagnets on the stator for more precise control.

Comparing Brushed to Brushless Motors



The older style brushed 2 wire motors traditionally use the "turns" to rate power output.

The newer 3 phase, 3 wire Brushless motors are rated in KV (rotations per volt) as well output in Watts.

It's hard to do a direct comparison because the torque band is so different between the two technologies but for modified Brushed motors here's a good ballpark formula:

Take the rating of brushless times 1.4 to get the roughly equal brushed equivalent (double-wind).

Example:

$6.5 \times 1.4 = 9.1$ a 6.5 brushless is approximately equal to a 9T brushed

$10.5 \times 1.4 = 14.7$ a 10.5 brushless is approximately equal to a 15T brushed

27T Brushed = 17.5 Brushless (Stock Spec)

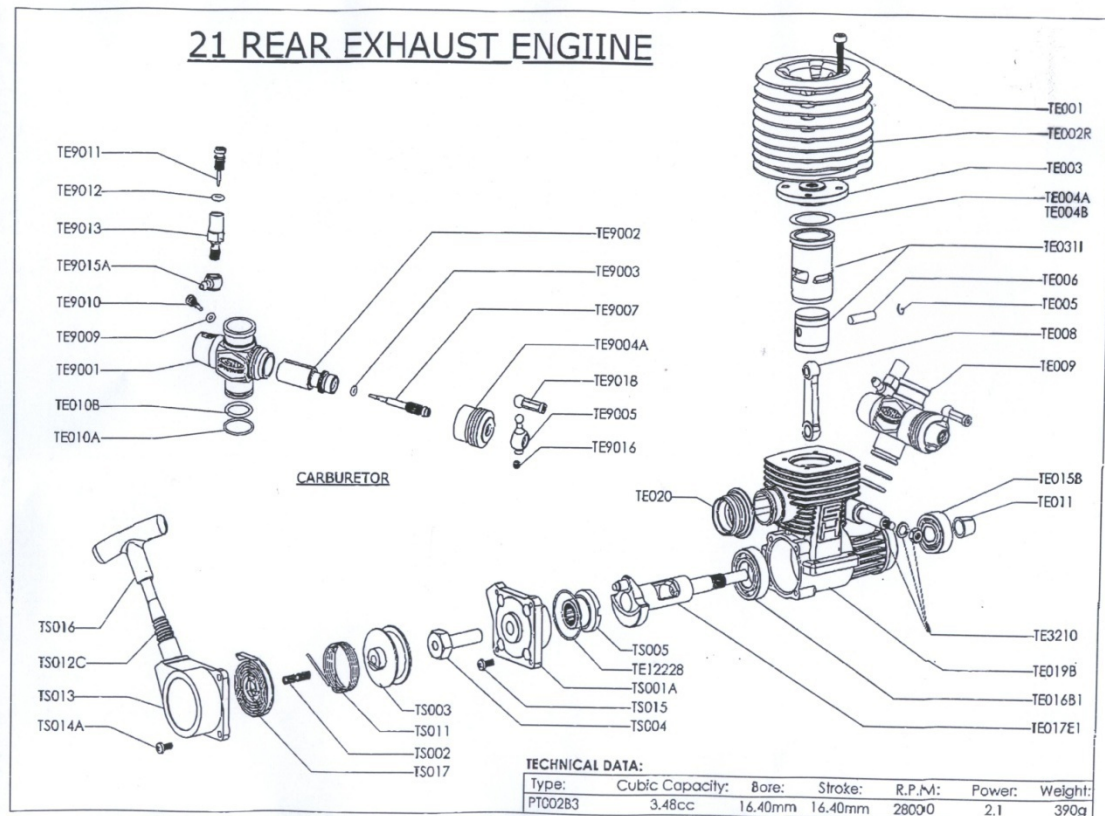
19T Brushed = 13.5 Brushless (Pro Stock Spec)

Under 19T Brushed = Under 13.5 Brushless (Mod)

Nitro Motors



Starting see *Starting a Nitro Engine*



Exploded view

Nitro RC Car engines come in many sizes from .05ci to .28ci +

The engine capacity is rated in Cubic Inches (imperial) of Cubic Centimetres (metric)

The Conversion for Cubic Capacity is as follows.

1 cubic centimetre (cm) = 0.0610 cubic inches (ci)

i.e .15ci / 0.0610 = 2.45cc

i.e .07ci / 0.0610 = 1.15cc

Most 1/16 scale cars use .05ci to .07ci

Most 1/10 Scale use .12ci to .18ci

Most 1/8 scale use .15ci to .28ci +

There are 3 basic "physical" sizes for engines and they can often be interchanged.

.05ci to .07ci

.12ci to .18ci

.21ci to .28ci



Idle Speed

To make the engine idle faster or slower, just adjust the black idle screw which is located directly below the air cleaner. By screwing in the idle screw it will make the engine idle faster and out makes the engine idle slower.

Mixture Settings

There are a number of areas you need to be aware of when running RC cars. However always make sure you start with a fresh new glow plug.

Most engine manufacturers pre-set the mixture screws for the average day on our planet.

This is called ISA (Industry Standard Atmosphere)

Temperature: 15 degrees

Barometric Pressure: 1013 HPA

Altitude: zero feet above sea level

Humidity: 40%

A common factory mixture is as follows however always check with the manufacturer of your engine.

High Speed Mixture (large screw) 2.5 turns out from fully screwed in.

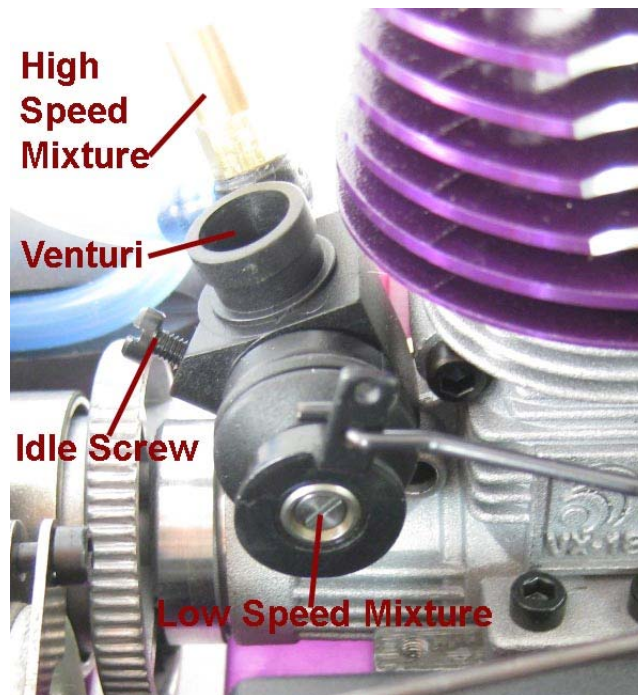
Low Speed Mixture (in the middle of the carburettor throttle actuator arm) 4 turns out from fully screwed in.

Idle Screw:

Carburettor Venturi open .5 to 2mm

It is not uncommon to have to adjust the mixture 2-3 times per day as the ambient conditions change throughout the day i.e temperature and humidity.

MIXTURE ADJUSTING



I once saw a circus trick where some #*(\$^@# body lit a match and then quickly opened a lid a can of petrol and put the match out in the petrol!

I'm sure this guy is probably either dead or badly disfigured now, but it taught me a valuable lesson. Petrol is not flammable????

It is only fuel vapour which is flammable, which is when the fuel is mixed with air.

Nitro engines use approximately 1 part fuel to 4 parts air. Petrol engines run approx 16:1. The right fuel/air mixture is crucial to make the engine running at its peak performance. The wrong mixture will cause overheating, excessive wear and cause the engine to stall. The carburettors job is to mix the correct fuel/air ration. To get this optimum fuel ratio we need to adjust the high and low speed mixture screws.

ALWAYS THINK OF THE MIXTURE SCREWS AS TAPS AS THAT IS WHAT THEY ARE.

Just like the tap in the kitchen, if you screw the tap in, the fuel reduces. (Creates Lean Mixture) Screw the needle valve right in and you will shut the fuel off completely. Just like the tap in your kitchen.

Wind the tap out lets more fuel pass through (Rich Mixture).

The mixture setting is always referred to as Lean or rich referring to the mixture of fuel and air. To lean out or richen the engine means to adjust the mixture of fuel and air going into the engine. Lean is the reduction of fuel to the fuel/air mixture. Rich is the addition of more fuel to the fuel/air mixture.

Lean

When you lean out a nitro engine you are adjusting the mixture so that there is less fuel going into the engine. This provides a little more horsepower but can result in very high engine temperatures. Too lean will wear out the glow plug prematurely and can lead to engine failure.

Rich

When you richen the nitro engine's mixture you're adding more fuel. This is the best and safest way to run an engine as it gives cooler engine temperatures. However if too rich you can not only bog the engine down and stall but also flood the engine and foul the glow plug.

ADJUSTING

If the engine suddenly dies while idling and you don't see a light stream of blue smoke from the exhaust then the low speed mixture is probably too lean.

If the car is slow to accelerate, emits too much blue smoke or a lot of unburned fuel from the exhaust, an inability to reach top speed, these are signs the high speed mixture is set too rich.

If the engine quits suddenly it is probably too lean. If the engine splutters to a stop, this is normally too rich. Too much smoke also means too Rich

If the engine gets so hot that a drop of water on the engine immediately starts sizzling and popping if it is also too lean.

Engine tuning and adjusting the fuel/air mixture involves adjusting the high and low speed needles on the carburettor. There are usually factory default settings provided by the manufacturer which provide a good starting point. Adjust each needle in very small increments.

Like the tap in the kitchen, turn clockwise to reduce the fuel (lean out) and counter clockwise to add fuel (richen). The low speed needle controls idling and low speeds. The high speed needle controls how the engine accelerates and runs at high speed.

Note: The high speed mixture needle has a greater effect on engine temperature. *See closeup illustration of fuel/air mixture needles.*

A LEANISH (HOT) ENGINE WILL ACCELERATE THE FASTEST HOWEVER IF YOU GO TO LEAN IT WILL CREATE TO MUCH HEAT AND DESTROY THE ENGINE

The trick is to get the engine running, then slowly lean it out until you get peak performance. Then wind the high speed mixture out a fraction to keep the engine slightly Rich.

Engine Temperature

The fuel/air mixture also determines the heat of the engine. A rich engine runs cool.

A Lean engine runs HOT.

Most engines have an operating temperature between 107-120 degrees Celcius.



Over 130 degrees can cause a lot of damage and also dramatically shortens the life of the engine.

Just remember, too rich will cause NO damage.

TOO LEAN WILL CAUSE DAMAGE

Always err on the side of being slightly too rich.

The ambient (outside) temperature, humidity, barometric pressure and the elevation according to sea level will adversely effect the engine's mixture settings so you need to adjust them to suit. Just because you had the mixture set in the morning does not mean it will still be ok in the afternoon, never mind the next day.

See also troubleshooting

ESC's (Electronic Speed Controllers)



An electronic speed control or ESC is a device mounted onboard an electrically powered radio control model in order to vary its drive motor's speed, its direction and even to act as a dynamic brake.

The ESC plugs into the receiver's throttle control channel or incorporated into the receiver itself, as is the case in most toy-grade R/C vehicles. Some R/C manufacturers that install proprietary hobby-grade electronics in their entry-level vehicles, vessels or aircraft use onboard electronics that combine the two on a single circuit board.

Regardless of the type used, an ESC interprets the information from the receiver electronically.

The speed of the motor is done again electronically by varying the switching rate of a network of "field effect transistors", or "FET's."

The rapid switching of the transistors is what causes the motor to emit its characteristic high-pitched whine, especially noticeable at lower speeds.

Most modern ESCs incorporate a battery eliminator circuit (or BEC) to regulate voltage for the receiver, removing the need for extra batteries. ESCs are normally rated according to maximum current, for example, 30 amperes or 30A. Generally the higher the rating, the larger and heavier the ESC tends to be.

Some ESCs support the newer lithium polymer batteries with a range of input and cut-off voltages. The type of battery and number of cells connected is an important consideration when choosing a BEC. A higher input voltage will result in a reduced power rating.

A standard Brushed ESC is designed for use with a 7.2 Volt battery pack. By using a higher voltage will overheat the ESC and burn it out.

Glow Plugs



Glow Plug

Nitro model engines do not use spark plugs like full size cars to create ignition. Like a diesel engine they rely on compression to generate heat to keep the engine going and an electric glow plug to get it started. As the piston rises it compresses the fuel / air mixture which causes the mixtures temperature to rise to due to the act of compression.

With the right mixture and a hot engine the mixture can actually ignite without even powering up the glow plug.

Glow Plugs are used to start a Nitro engine and the heat generated from compression keeps the glow plug lit.

Heat is caused by compressing a gas . The opposite is effect is un-compressing a gas, this becomes cold. Try holding your finger down on a can of fly spay and you will feel the can getting colder.

This by the way is how a fridge works.

If you car won't start, try replacing the glow plug and see if it fixes the problem. Also, make sure the glow plug igniter is fully charged.

The typical symptom for a blown glow plug is the stalling of the engine when the glow plug igniter is removed and or the engine misbehaving in any way. Glow plugs can effect idling, mid revs and high revs or of course not allow the engine to start at all. Don't be fooled by removing the glow plug and finding it still glows, over 90% of worn out glow plugs still glow. The only way to know for sure is to replace it and start the engine again.

I can't tell you how many times I have tried to adjust a rough running engine with the mixture screws only to find out it was the glow plug causing the rough running. Glow plugs are consumables like the fuel and can last for months. However I have gone through 3 in one day. There are two things you can do to maximise a glow plug's life.

1. Make sure the mixture is not set too lean - this will very quickly burn the fine filament in the glow plug. The mixture must be adjusted through the day for the day's changing ambient conditions.
2. Make sure you never leave the battery connected to the glow plug for more than 10 seconds after starting as this will quickly burn it out.

You can manually check the condition of a glow plug with a magnifying glass and a small torch.

When the glow plug is new, all of the coils will be very similar, when it is worn, you will see some of the coils are no longer perfectly coiled but instead unsymmetrical and distorted. You can also see the colour of the coils, this shows how well the mixture is set. The coils should be a grey to white colour, too white means to lean.

Note: If you remove the glow plug and plug it into the igniter, it will still glow even when worn out.

Glow Plug Specifications

How to select the correct Glow Plug.

Glow plugs are rated with different temperatures from #3 to #6. Other temperatures are available. However it is very rare to use these on modern engines. Most glow plugs require 1.5 Volts to operate.

3 Hot – Most common – for low Nitro Fuels

4 Mildly hot – For 10 – 15% Nitro fuels

5 Medium - For high nitro 25% + Nitro Fuels

6 Cold – For high compression engines and high nitro methane fuel used in racing.

Symptoms:

Your glow plug temperature range is too cold when:

The engine power is weak or has weakened from previous levels.

The engine slows down considerably or stops after removing the glow plug igniter, despite correct adjustment of the needle valves. As an example, if a # 4 plug gives you the above symptom, switch to a # 3 plug instead.

Your glow plug temperature range is too hot when:

The overall engine running is rough, backfires and/or a loss of power.

The glow plug filament is broken or collapses frequently.

Don't forget, the higher the percentage of Nitro in the fuel, the harder it is to tune.

Nitro engines are extremely dependent upon the type and quality of the glow plug used. Some glow plugs use a platinum alloy coil, which uses a thick diameter wire for long life. The thicker wire coil also eliminates the need for an "idle bar" as found on other brands of glow plugs; idle bars tend to reduce top speed slightly but they achieve a more stable idle speed.

IDLE BARS

Idle bar glow plugs are for engines having trouble transitioning from idle to high speed.

When the throttle is opened from idle, the incoming air and fuel strikes the glow plug's heated coil and can cool it to the point where it will no longer ignite the fuel mixture.

An idle bar can help by acting as a physical shield, helping to keep the coil from cooling off too quickly.

If you are having problems transitioning from Idle to full power then using a glow plug with an idle bar. Some modellers use idle bar plugs in the winter only, since the glow plug tends to lose heat faster in the colder environment.

HOT PLUGS

A hot plug will heat up faster and stay hotter however the amount methanol in the fuel cools the temperature. The more methanol you are using the hotter the plug you should use.

In other words the more nitro and/or oil you use, the colder the plug needs to be. For most people using fuel with 5-15% nitro, a hotter plug is normally sufficient. Trial and error is the best way to determine the right glow plug for your application.

MAINTENANCE

NITRO ENGINE MAINTANANCE

Nitro 2 stroke engines are pretty basic with only a few moving parts see exploded view in Nitro Motors.

For serious racing we pull the engines apart after every race but If you are not a serious racer it is still a good idea to pull the engine apart after ever 20 - 30 tanks of fuel to make sure everything is wearing well and of course to make sure everything is tight.

Disassemble the engine on something like an old towel and keep note of where the parts come from. Most manufacturers supply an exploded view which can help when re-aassmebling the engine. The main thing with engine cleaning is to clean out any dust and check for wear.

The manufacturers exploded view contains part numbers of every engine part so if a part is worn, just replace that part.

Another thing to check is for air leakages as an air leakage dramatically changes the mixture ratio.
See also troubleshooting

After Run Oil

After running a Nitro Engine you should perform the after run maintenance. Part of that after-run maintenance includes lubricating the pistons and the internal parts. Nitro hobby fuel contains alcohol which when not used dries out and can leave the internals dry and therefore can oxidize (rust). After Run-oil is used to counteract this drying out. Use only a few drops at a time. After Run Oil is available at most hobby shops.



Dust Cleaning

The 2 best ways to clean a dusty RC car is Compressed Air and for a nitro car, a Spray bottle of Methylated spirits. Just hold the car up in the air with one hand holding the front crash bar and spray away. Be careful to not soak the electronics with Methylated spirits.

These days I take a small compressor to the race track however you can buy pressure cans of compressed air from electrical part shop. i.e Jaycar and Dick Smith



Cable Ties

Every serious racer has a pile of cable ties in their toolbox. If you have a loose dangling wire you can be sure it will find a way to rip out or rub on something until it creates a short circuit and catches on fire! If it's loose, tie wrap it. This also goes for ESC's, never trust double-sided tape - in a race they will tear off. Tie wrap them too.



MAINTENANCE – AIRFILTERS



The best way to clean the air filter is to soak it in mineral turpentine.

Ensure the filter is then dried and oiled with hobby air filter oil or just the Nitro fuel. There is plenty of oil in most hobby fuels.

Always check all of the nuts and screws after each tank of fuel when the car is new and then regularly after break in. I check the car thoroughly before every single race. I cannot tell you how many races I have forfeited because of one nut!

Electric Engines

MAINTENANCE SHOCKS

See Suspension

MAINTENANCE - BRUSHED MOTORS

Brushed motors require much more maintenance than the newer Brushless motors. With proper maintenance, stock or modified motors will stay in peak condition with maximum power, speed, and rpms.

Use a high quality motor spray to clean out the dirt and carbon deposits. It is best to do this after every run. Put a drop of oil on each bushing or bearing.

Warning: Do not use WD-40 or brake fluid - these may damage your motor.

Electric Engine Brushes

To keep in Race Spec replace motor brushes after 20 - 30 runs (stock motor) or 10 runs (modified motor). Also, if the tip of the brush that touches the commutator has turned purple, it is time to replace it.

Electric Engine Commutator

Before reinstalling new brushes, it is good to have the commutator "trued" by a diamond bit lathe. This will ensure that the commutator is perfectly round and smooth.

Electric Engine Springs

Brush springs will lose their tension. You can check this with a spring tension checker device. But if you can afford it, change to brand new springs the same time you change the brushes.

Electric Engine Magnets

Time and excess heat will cause the magnets of a motor to weaken. This will drastically reduce a motor's power. There are devices called magnet zappers that try to restore a magnet's strength, but this is usually temporary. Once you feel the magnets have weakened, it is best to buy a new can (with magnets) or buy a new motor.

Brushless Motors

Brushless motors have very few parts, so it's easy to take them apart for cleaning. Most are held together by a few screws on the front, back, or sides of the motor case. Remove the screws, disassemble the motor and lay the parts on a clean rag. Be careful not to lose any spacers or washers that are used to properly align the motor shaft (and magnets) inside the motor. Also note the order in which the spacers or washers were installed.

Use a small brush and compressed air to clean the inside of the motor and a very light oil of the bearings on each end.

Regularly Tighten Screws

All radio controlled planes, cars, helicopters, boats etc will continually vibrate screws loose. On our race cars we always use Loctite (a soft glue) when tightening the screws as this will help keep the screws tight. Loctite is available from most hardware stores

Gearboxes

Most gearboxes do not require any lubrication as it just attracts dirt. Only lubricate sealed gearboxes.

Only metal on metal requires grease, nylon to metal or nylon to nylon does not require lubrication.

Differentials

Differentials where there is metal to metal contact do require grease. Most greases are ok. However we use a light synthetic grease on our race cars. As a general rule, the thicker the grease the more friction however the longer the grease will last.

Radio Controls



RC cars, trucks and buggies almost always use a 2 channel Radio Control to control the motor and steering. All hobby quality radios should be fully proportional.

This means that your model responds directly to how much you move the controls on the transmitter. In other words, if you move the throttle trigger on the transmitter just a small amount, then the motor will only increase slightly. Squeeze it all the way and the motor will go to full throttle.

The same goes with the steering - if you just turn it slightly then the model will only turn slightly.

This is different in cheap toys. Turn the cheap toy slightly left and it will go full left with no proportions.

A fully proportional rc system gives you complete control of your model.

Transmitter (abbreviated to 'tx')

Most RC car transmitters these days are the pistol grip style. Rarely do we see the traditional 2-stick kind. The choice of transmitter comes down to personal preference, as they both do the same thing.



Above, a pistol grip and a traditional 2 stick transmitter

Most people prefer the pistol grip transmitter as they are easier to hold and most people also find it easier to control the car.

With a pistol grip transmitter, the model is controlled by the throttle trigger while the steering is controlled by rotating the wheel of the transmitter.

Some of the more expensive Transmitters can have features as listed below.

Exponential



This is where you can adjust the sensitivity i.e when you turn the steering it is not sensitive from the straight ahead position. However the more you turn the more sensitive it can become. This is very useful for high speed racing where a slight steering movement makes big change in direction.

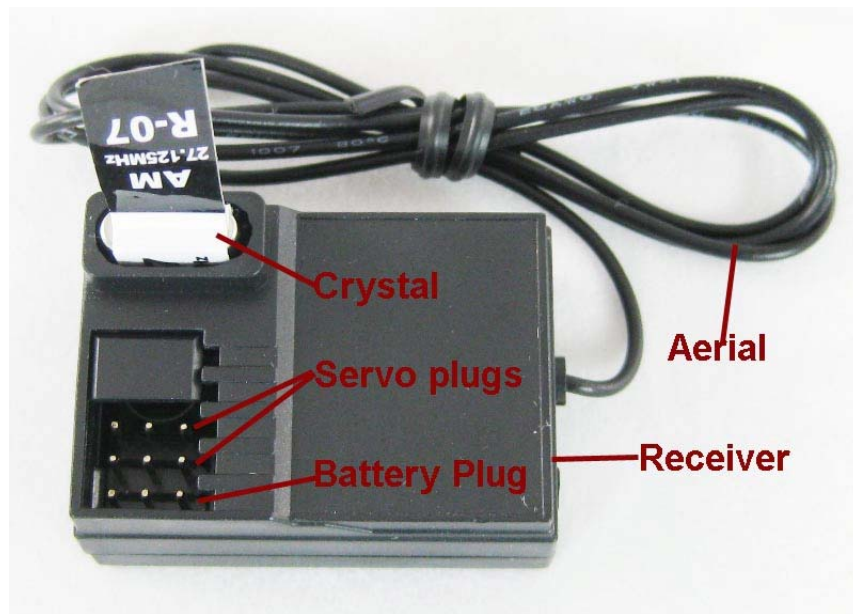
Model Memory

This is so you can setup the transmitter for different models with each model having with different trim, exponential, rates etc.

ABS – Anti Lock Braking

This works by pulsating the throttle / brake servo and can stop the wheels from locking under hard braking if adjusted correctly.

Receiver (abbreviated to 'rx')

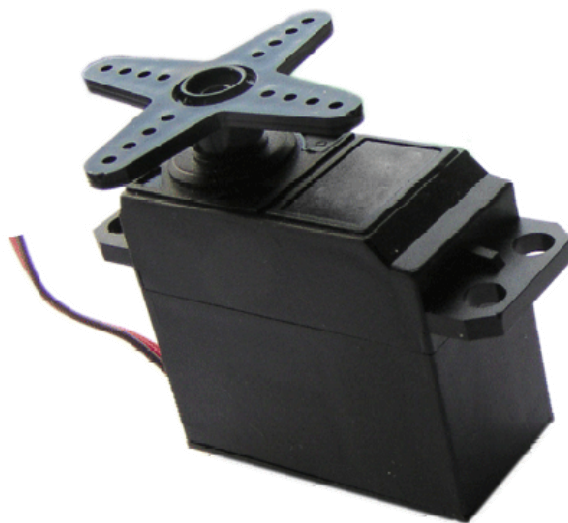


The receiver is installed into the model and receives the signal that is sent out by the transmitter.

A wire antenna extends from receiver and should never be cut or looped up to reduce its length; by doing so, its ability to receive the signal from the transmitter is drastically reduced. The aerial should be thread through a flexible upright plastic straw.

The signals received are then passed onto the servos and or Electronic speed control (electric car)

Servos



A servo normally has a plastic outer body with a small but very powerful electric motor and gearbox inside. The servo's gearbox consists of a set of plastic or metal gears. These

gear in turn the servo horn located on the top of the servo body. The servo horn is used to push / pull the throttle and steering.

A nitro car has 2 servos, 1 is connected to the throttle and brake and the other is connected to the steering assembly of the car.

An electric cars has one servo for the steering and an ESC (Electronic Speed Control) to control the engine see *esc*

There are many different types of servos available and they are normally rated in speed (speed of rotation) and power (torque).

An example is a large model will require a lot more torque to turn the steering requiring much more powerful servo than a smaller model.

A race car requires a very fast steering servo to give the driver instant response.

An off road truck requires a servo with a lot of torque and metal gears in the servo to eliminate breakage.

Crystals



Crystals determine which channel (frequency) the radio control operates on. For rc cars, a set number of frequencies are designated in most countries. Check with your local hobby store to find allowed frequencies in your country.

Both the transmitter and the receiver need their own crystal to operate and they usually have the same frequency. Some crystals need to .455mhz apart to work however these types of crystals are rare.

Although you can't change the main frequency band of your rc set (ie from 27MHz to say 30MHz), you can change the frequency in that band i.e from 27.145 to 27.195 simply by putting in a different set of crystals.

It is always a good idea to carry at least one spare set of crystals with you, so that you can change channel at anytime if other drivers are using your channel.

Batteries for your Radio Control

Most RC Transmitters use 8 X AA size batteries and 4 X AA for the receiver.

Note: Electric Cars do not require receiver Batteries as the receiver is powered from the main car battery pack.

Radio control sets don't consume batteries too quickly but low battery levels will result in your car going out of radio range earlier with a consequent loss of control.

It's a very good idea to buy rechargeable batteries. Nickel Cadmium (NiCad, or 'NiCad's') and Nickel Metal Hydride (NiMH) cells are commonly used in rc systems however try to avoid the older NiCad's as they are prone to memory problems. NiMH cells have greater capacity and performance than NiCad.

Rechargeable batteries are quite a bit more expensive to buy than 'dry' (non-rechargeable) ones, but they soon pay for themselves. Typical NiCD or NiMH batteries last for around 1000 charges.

Always be very aware of the battery level in your rc system

If in doubt, charge or replace!

SPREAD SPECTRUM



The information above relates to AM and FM RC systems with a frequency between 27 and 72 mhz however technology is changing and many people are moving to the new 2.4GHz 'spread spectrum' radio technology. The system operates the same, but there's a big difference in how the transmitter and receiver communicate with each other.

When you turn on the transmitter and receiver they both scan the designated RC 2.4GHz frequency channels until a free one is found, then they lock or 'bind' together on this channel. A second channel is also locked on to, so if the first one fails for any reason then there is a back-up channel that the system can still operate on. Once bound, the channels become secure and impermeable to any interference.

2.4 GHz Spread Spectrum radio sets are becoming more common, especially with RC planes and rapidly replacing AM and FM sets. The instant response and secure channel bond between the transmitter and receiver making crystals a thing of the past.

Another huge bonus of 2.4 gig is the aerials are only a few inches long. This means no more snapped aerials!

Selecting Reverse (Electric Only)

When you first push the throttle lever back, this is the brake. To select reverse you need to push the lever back a second time. Note, if the trim is not set correctly on the transmitter to neutral, reverse will not engage.

Fail Safes



When a model loses the transmitter signal there is nothing to tell it to decelerate.

The best solution for this is to install a Failsafe module which will automatically decelerate the car.

To install most" failsafes"

1. Unplug throttle servo from the receiver
2. Plug the failsafe into the receiver where the throttle servo was plugged in
3. Plug the throttle servo into the failsafe.
4. Move the throttle on the transmitter to the idle position and press the button on the fail safe to lock in the return position. The return position is the position the throttle servo will return to if there is a radio problem.

Suspension

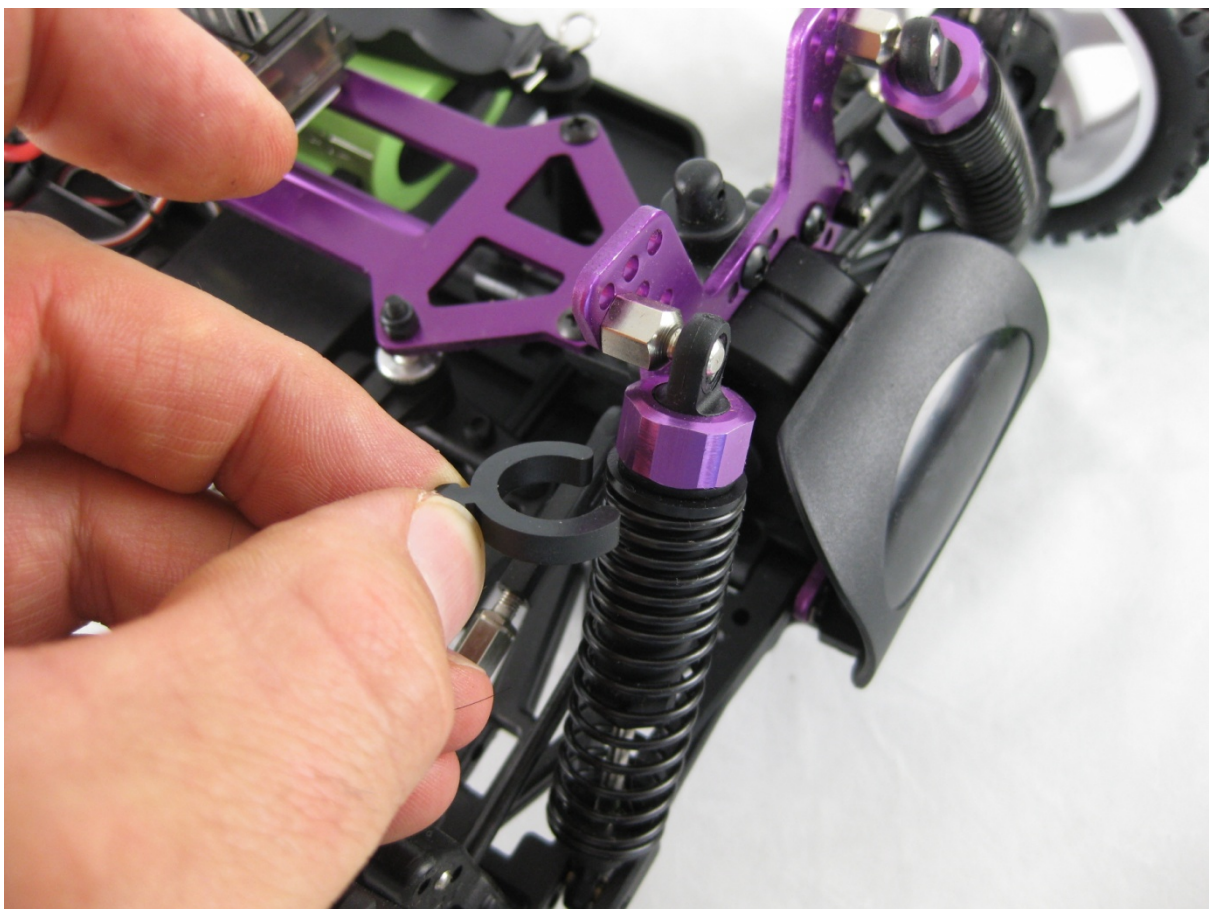
Shocks and springs are part of the suspension in RC vehicles. Oil-filled shocks give RC vehicles more stability over rough terrain. Without the oil, the shocks compress and rebound too quickly and fail to absorb or dampen the bumps in the road. When you feel

that your shock absorbers aren't performing properly you should check the fluid level and add more oil to the shocks.

Shock oil comes in different weights such as 40, 70, or 100. We use and recommend 60 but experiment with the conditions under which you run it. Changing the weight of the oil changes the damping rate -- the compression of the shock -- so that you can finetune it for different road or track conditions.

C Clips

The C Clip spacers are to make the suspension more firm. To install the C Clip, push the spring on the shock absorber down and push the C Clip on. The C Clip will force the spring down making the shock harder. Some cars have threaded struts which eliminate the C clips.



The suspension works best as follows.

Rough Terrain - Soft Suspension (no C Clip)

Hard Surfaces, i.e road, - Hard Suspension

The manufacturers sometimes include different size C Clips so you adjust to suit the surface.

Camber Angle

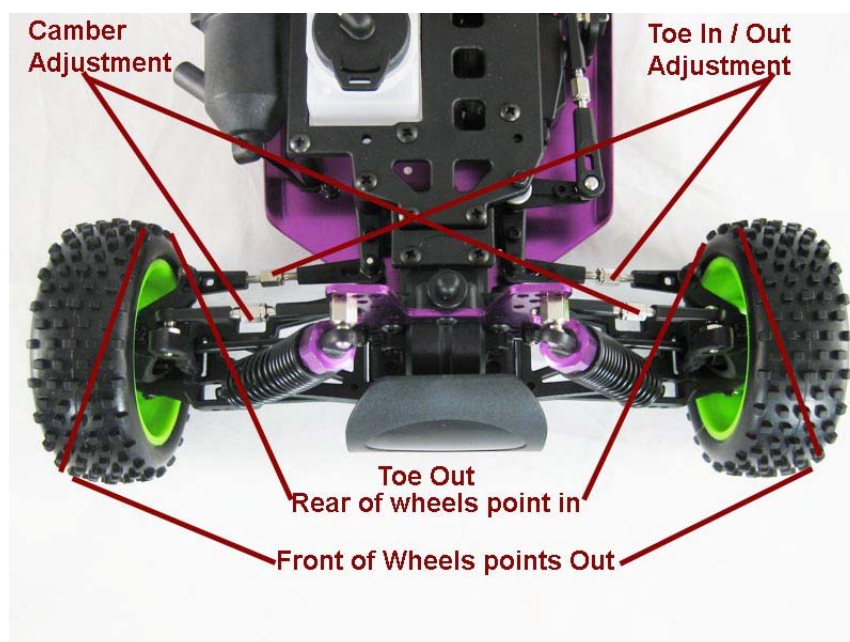
Camber angle is the angle of a tire in relation to the upright position (tire axis) Most race cars have negative camber to give more grip when cornering. Positive camber will make a car very nervous (twitchy).

The downside of negative camber is wears tyres out on the inside edge and reduces grip in a straight line as less of the tyre is contacting the road. This is felt under acceleration and braking.

For straight line speed zero camber is best.

For cornering, some negative camber is best. Different cars, tyres, tracks, shocks, surface conditions etc require different amounts of negative camber. The best way to learn how it affects your car is to set the car up for maximum positive then neutral then maximum negative. You will then get a feel for how to set the car up for your tracks conditions.

Toe in / Toe Out



Front Toe out enables a car to turn into a corner easier however it will wear out the inside edge of the tyres. Too much toe out will make the car turn in too fast and possibly oversteer. Again the only way to get it right for your car and tracks setup is to test and test again at different settings.

Hotting Up and spare parts



Like a real full size car it comes down to basic physics for hotting up.

To Accelerate faster you need more power, less weight, less drag and more traction.

With electric you can quickly get more power from a higher voltage battery, i.e an 11.1 volt lipo battery but make sure your ESC and motor can take the extra voltage. Of course upgrading the motor to a more powerful brushless motor is another option. *See brushless motors*

With a Nitro car you increase the percentage of Nitro in the fuel or even better replace the engine with a more powerful version. High Nitro fuels can be difficult to tune.

You can reduce weight by replacing metal parts with composite or polycarbonate parts.

You can reduce drag by only using Ball Bearings and not bushes. I highly recommend this.

Most RC Car manufacturers these days include a list of hotup / hopup upgrades in the back of their instruction manuals.

Everybody has their own take on what the best hotups are but this is my list in order of importance.

1. If your car has brass bushes replace them straight away with ball bearings. This can make a very big difference not only in speed but in controllability.
2. Upgrade the servos to as fast as you can afford. This can make a real difference in car control.

3. If your car is electric, upgrade to a brushless motor. *See brushless motors*
4. Nitro - hmmm, basically the more you want to spend on a motor, the faster it will go. *See below*

Nitro Racing Engines

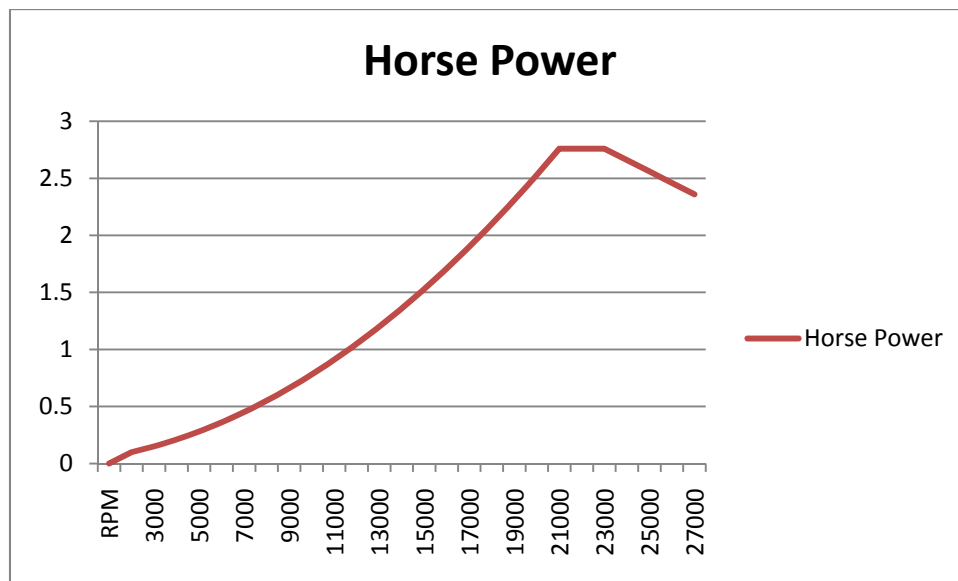
Most newbies want to bolt a full house race engine into their new car. However it is crazy for a newbie with little or no tuning experience to learn the ropes trying to tune a highly strung racing engine that cranks out 30,000+ RPM. First, learn how to tune your engine. Then learn how to drive and setup your car. Later, when your old engine gets tired then replace it with a more powerful version.

Which Brand of Engine?

What makes a Ferrari more powerful than a Commodore? Why does a race engine put out more power and cost more? It is the many small details that add up to make a big difference. It is not just on the engine design, but also on the manufacturing of the engine. Many racing engine manufacturers use very high tech CAD CAM, CNC machining, High precision balancing equipment etc to make their parts. This R&D and quality of precision workmanship is what makes all the difference.

The ability for a piston and sleeve assembly that will seal properly at high temperatures and last while being used in an engine capable of turning 30,000+ RPM, is not easy. One single out of spec part could cause the engine to fail.

Engine displacement (capacity) does not mean everything when selecting a race engine. You need to look at the horsepower curve and where the max power comes in. Check the graphs supplied by the engine manufacturer. The best engines are not too peaky, the flatter the power curve the better. There is nothing worse than an engine which suddenly goes from being flat to suddenly making its max power. This is impossible to control half way around a corner.



The table above shows a nice smooth power curve. No nasty surprises here.

I always check the forums when I am purchasing a new engine to see what feedback others have given. *See links*

Torque vs RPM

Engines have operating characteristics that make them more suitable to a specific task.

For a truck, good strong low down torque is required however a road race car needs to rev high for maximum speed.

This is trade off, you cannot have both.

Personally I always go for the linear power curve and accept the smaller HP number on the side of the box!

To make the car handle better, there are many ways to tune the car *see suspension*

Electric Starters



Electric Starters replace the pull start.

To install the rotor start, you just unscrew the pull start and replace it with the rotor start socket.

To start the car you then push the rotor start drive shaft into the socket and squeeze the trigger - that's it.

Starter Boxes

With a starter box, you simply just drop the car onto the starter box and it triggers an electric switch which in turn starts spinning the engine over.



Starter Kits (for Nitro Cars)



Starter kits normally contain the basic tools required to start a nitro engine. They normally contain the following;

Fuel bottle to squirt the fuel into a car's fuel tank

Rechargeable Glow plug igniter and charger

Small screwdrivers for adjusting the mixture

Cross wrenches for undoing different size nuts

Note: You will still need to purchase fuel and batteries for the radio control

Tools



Most cars don't come with tools but most people have basic tools at home that are suitable for these cars.

You will need Phillips Head screwdrivers, small jeweller's screwdrivers (for mixture screws), a set of small sockets and an Allen Key set. You can purchase these at any hardware store or you can buy specific factory tools which do make working on the cars much more enjoyable. I have included some of the popular factory tools below.

Piston Locker – Clutch removal tool.

This device screws into where the glow plug goes and stops the piston moving, locking the engine so you can undo the nut on the end of the crank shaft.

Scissors for cutting out body shells

These special scissors with round blades are perfect for cutting out wheel arches and all round parts of a body shell

Dremel



Dremels are a modeller's best friend, perfect for shaping body shells, cutting metal, polishing etc.

Reamer

For cutting round holes for body posts in body shells

BODY SHELLS



Many body shells these days come pre-painted and you just need to have the excess shell removed. Use scissors with curved blades to cut out the wheel arches and other curved parts *See tools*

Use sandpaper or a Dremel to clean up rough edges. *See Tools*

Use a Reamer to cut holes for body posts. *See Tools*

If your new body is clear, make sure you paint it from the inside using paints approved from the manufacturer. The wrong paints will not stick and may melt the shell.

Troubleshooting

Nitro Cars



Exhaust Manifold Leaking where it attaches to the engine

To fix the leak, remove the manifold, clean it with methylated spirits and then use Silicon Gasket Seal to put in between the engine and the manifold. Silicone Gasket Seal is available from hardware stores and motoring accessories shops.

You will also need to put some Loctite on the screws which hold the but make sure you clean the screws well before you apply it.

Screws too tight to remove

The Grub screws use Loctite to keep them tight but this can make them difficult to undo sometimes. To make it easier to remove, heat the screws with a portable soldering iron or similar. Most portable soldering irons come with a heat tip which is perfect for heating screws including grub screws. See the picture below.



Portable Soldering Iron

Also, make sure you use a metric Allen key if your car is metric based or imperial if the car uses imperial nuts and bolts. To find out which, just check the back of the manual to see the measurements of the nuts and bolts.

Problems starting the engine

Go through the following checklist

1. Make sure the fuel is new and approx 15% Nitro. Remember, the higher percentage Nitro, the harder it is to tune the engine.
2. Replace Glow Plug and MAKE SURE the copper Glow Plug is fitted
3. Make sure fuel cap lid is fully closed as the exhaust pressurises the fuel tank. If the lid is not 100% closed the tank cannot pressurise. By pulling over the engine with your finger covering the exhaust outlet, you should be able to see the fuel being forced from the fuel tank to the carburettor. This is caused from the exhaust pressuring the fuel tank. You can also check this manually by removing the silicone hose from the exhaust pipe and manually blowing down tube.
4. Make sure Glow Plug igniter is fully charged

5. Make sure head bolts are tight - these regularly come loose and the engine will lose compression and not start
6. Reset Mixture settings to factory . On many motors the High Speed mixture factory setting is 2 1/2 turns out. Often the Low Speed is 4 turns out. However check the manual for your engine.
7. Put 1-2 drips of fuel in carburettor
8. Is the fuel line full of fuel?
10. Is the air cleaner blocked? If it is clean it out with petrol or methylated spirits.
11. Make the mixture more rich by winding out the low speed mixture screw 1/8 of a turn at a time and try again. Prime the engine each time before starting each time by putting your finger over the exhaust and pulling the cord 1-2 times.

An engine requires four things to be right to start;

1. A Strong Glow (Glow plug and Glow Plug Igniter)
2. Good Compression (Head Bolts and Glow Plug Washer)
3. The correct amount of fuel

The correct amount of fuel is governed by the mixture screws - how open the carburettor is and the pressurization of the fuel tank.

Removing the glow plug and seeing if it is wet or dry will quickly tell you if the engine is getting fuel.

Reversing - Car won't go backwards

Most Nitro cars do not have reverse.

For an electric car, when you first push the throttle lever back, this is the brake. To select reverse you need to push the lever back a second time. Note, if the trim is not set correctly on the transmitter to neutral, reverse will not engage.

2 speed, Second Gear - not sure if it is working

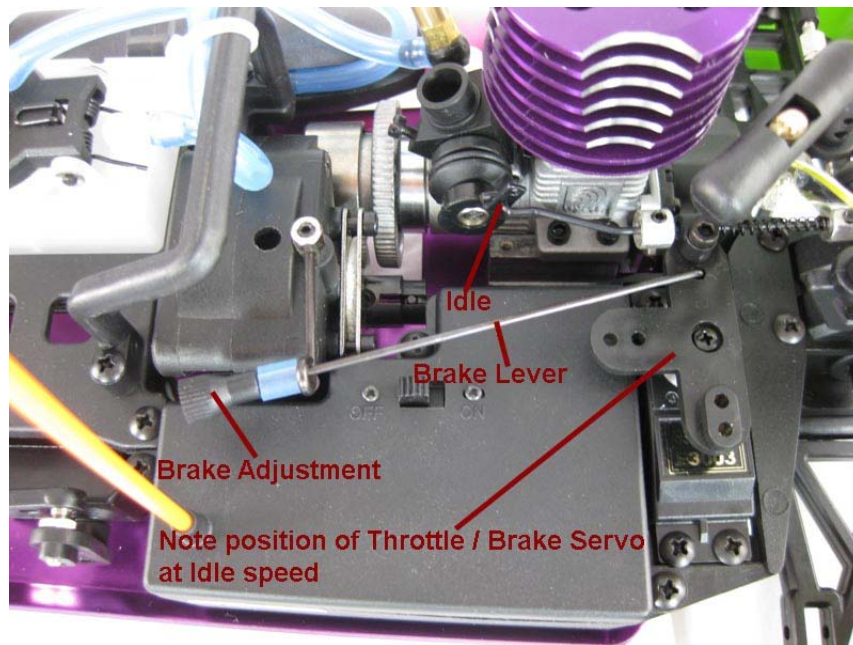
The best way to test if the car is getting into second gear is to run the car on flat bitumen with the mixture tuned for the day. Note it can sometimes be very hard to hear the gear change as it is not like a full size car or motor bike. The gear doesn't change as such, the

second gear is continually spinning and then enabled by a pin which comes out under centrifugal force. It is very unusual for the second gear not to work.

Most times if second gear is not enabling it is just because the car has not been able to get up enough speed for the centrifugal force to come in to play. This is normally caused by either the engine not run in, the mixture not set correctly or the surface is too rough or restrictive for the car to get up enough speed. Running the car on grass is like running a real car through a cane field.

Another reason the second gear may not be engaging is the engine may be now located too far away from the gearbox. Remember as per the instructions the engine needs to be adjusted during the run-in after the first tank of fuel and then re-checked as car runs in.

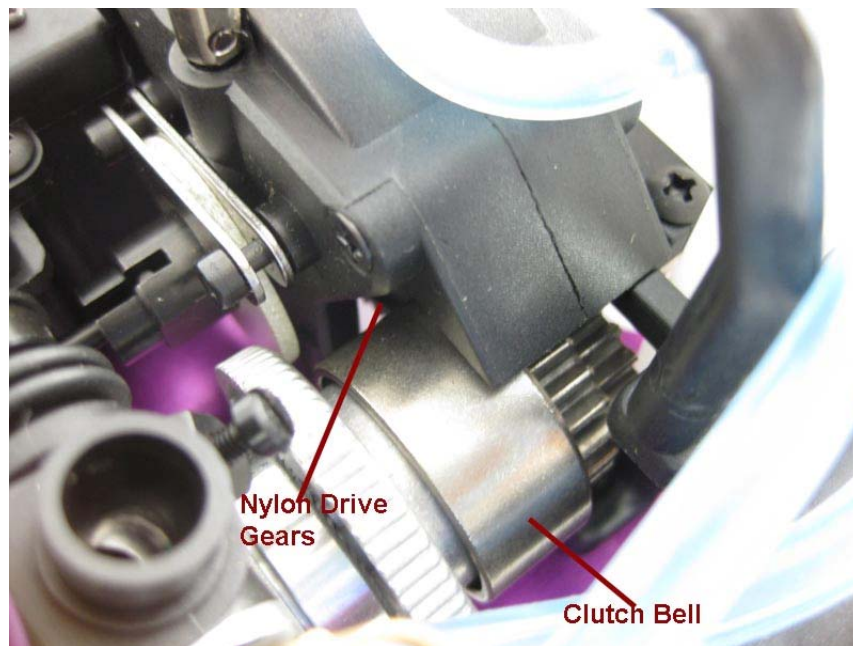
Brakes not working – Adjusting



To adjust the brakes just wind in the black plastic knurled screw in the brake lever rod. This is the rod from the accelerator servo. It is also the same rod which controls the throttle of the engine.

By winding the knurled knob in it will make the brakes engage earlier.

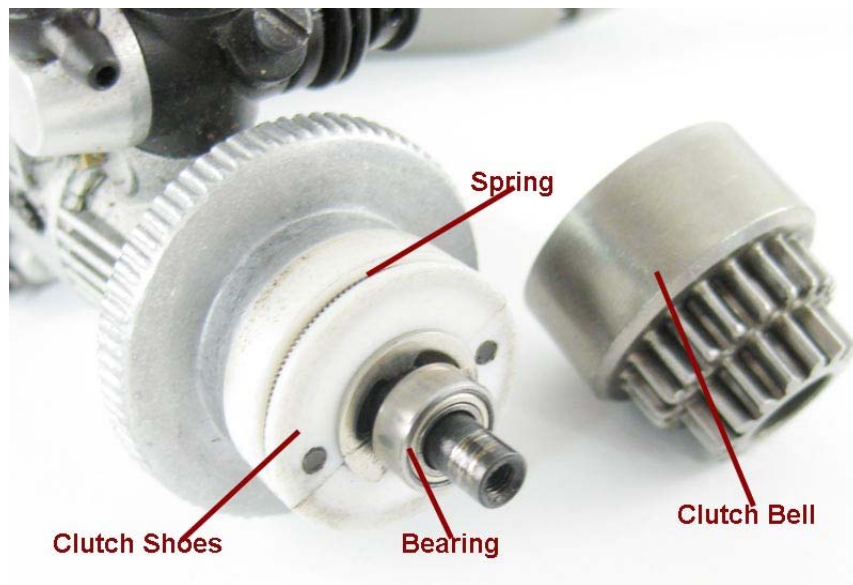
Clutch overheated



If the clutch suffers damage from overheating you will need to pull off the clutch bell housing and see the degree of damage/melting that has occurred to the parts inside.

You then need to match up the damaged parts with the pictures of the parts listed in the instruction manual and replace the damaged parts. Each part has its own part number. See *picture below*

Clutch Sticking



If the clutch is sticking, this can be caused by some residue inside the clutch bell, i.e dry fuel. Try washing it thoroughly with methylated spirits.

Idle too high



If the engine is idling too high this is caused by either the idle speed screw wound in too far or the transmitter throttle trim is set incorrectly. *See radio controls* The idle screw is usually the black screw directly under the air cleaner. Just wind the idle speed screw out until the engine idles correctly. Of course make sure the wheels are off the ground while performing

any adjustments with the engine running. Also make sure the idle is not too high with the brakes on as this will cause the clutch to overheat.

Idle Too Low

If the car stalls when the brake is applied, it just means the idle speed screw is wound out too far. This is normally the black screw directly under the air cleaner. Just wind the idle speed screw in until the engine idles correctly. Of course make sure the wheels are off the ground while performing any adjustments with the engine running. Also make sure the idle is not too high with the brakes on as this will cause the clutch to overheat.

Lack of pressure in fuel pipe

Lack of pressure in the fuel pipe is usually caused by one of the following:

1. The fuel cap not properly sealed
2. An air leak i.e split hose or leaking manifold
3. Lack of engine compression (loose head bolts, loose glow plug, glow plug missing the copper washer)

Check that the fuel cap is sealed correctly and there is no dirt stuck in the seal. Test the seal by pushing down on the cap while priming the engine. *see priming*

Also, try removing the silicone hose from the exhaust and manually blow in it to see if this pressurises the fuel tank and pushes fuel into the carburettor.

Loss of pressure in the fuel pipe normally means that the cap is not sealed correctly.

Another commonplace fault can be air is leaking from the silicone joiner between the exhaust manifold and the exhaust pipe. To stop this, remove the zip ties then remove the silicone joiner. Clean the oil from the exhaust and manifold then re-install the silicone joiner with new zip ties.

It is a good idea to check the joiner on new cars as they can move as the car runs in.

Leaking Head

Leaking gas from the head is not unusual for a brand new engine and will normally stop after the engine is run and the head bolts tightened.

After another 10 - 15 tanks the head bolts will need to be tightened again and this should stop any leakage.

This can only be done after the engine has been used as heat is required to bed the engine in.

Melted Gears - Looks like Stripped Gears

What has probably happened to the nylon gear is it has melted from the heat created from the clutch slipping as a result of a high idle speed or the wheels have been unable to spin freely due to the brake being on or the cars wheels being unable to freely spin.

It is very important to always start the car with the wheels off the ground and the brake off otherwise the heat generated from the clutch slipping will melt the nylon gear. Once the car is up to speed or racing this will not occur. It will only occur if the wheels cannot spin freely i.e. the car being held.

Many modern RC cars use a combination of nylon and aluminium gears as you cannot have an aluminium gear turning another aluminium gear as they would both wear out straight away. Steel on the other hand is far too heavy and will cause the aluminium gear to wear out.

The way to stop the high speed idle is to just adjust the idle speed knob on the transmitter as per the manual and/or the idle screw on the engine.

Stripped Gears – See Melted Gears

Hot engine -cutting out

This occurs when fuel evaporates in the carburettor before getting to the engine.

To stop this the engine needs to be made to run cooler.

There are 3 methods to do this.

1. Make the mixture more rich by winding out the high speed mixture screw out a fraction of a turn at a time and try again.
2. Use a fuel with less Nitro on a hot humid day.
3. Use a cooler Glow plug. These come in many grades from hot to cold. *See glow plugs*
4. If it still persists, use a different make of Nitro Fuel.

Pull start breaking

Pull starts break when the cord is pulled too hard on a flooded motors and pulled past 20 centimetres. The cord will snap if pulled more than 20 centimetres as this is the maximum length on many motors and it will snap if pulled more. Also, be very careful not to pull the cord too much if the engine is flooded as fuel being a liquid, does not compress and the

engine will lock. If the engine floods, remove the glow plug and pull over until all of the fuel has been evacuated.

Pull start very hard to pull

If the pull start is very hard to pull it normally means the engine is flooded.

Fuel being a liquid, does not compress and the engine will lock. If the engine floods, remove the glow plug and pull over until all of the fuel has been evacuated.

Seized Engine / Carburettor

A seized engine or carburettor is usually caused by dried out fuel from the evaporation of the fuel. It is rare for a mechanical failure however common for fuel evaporation.

To remove the brown gluey substance, just soak the carburettor / engine in methylated spirits for 24 hours then use a paint brush to clean off the excess.

For the engine, you may need to release the stuck piston. To do this, remove the head and tap the piston down with a blunt object like timber dowel. The head is normally held on with 4 screws.

Troubleshooting problems common to Nitro and Electric

Differential Slipping

IF the diff slips and/or damages the gears, it normally needs to be shimmed so the gears mesh correctly. This is done by installing a shim / washer before the crown wheel. This pushes the crown wheel onto the pinion.

Dogbones come out

This is normally either the lower control arm or the dogbone is slightly bent or there is something loose in the front. This problem can be fixed by either replacing the bent part, tightening the loose parts or inserting a small piece of rubber at the end of each dogbone inside the cup which the dogbone inserts into. The piece of rubber is a trick we use on our race cars to stop the dogbones coming out in fast crashes. We just cut a pencil eraser for the rubber.

If there has been a loosening off of the fitting where the dogbone enters the universal joint on the diff end, you will need to loosen this off with an Allen Key and move it out slightly

with a small screwdriver and then retighten it to adjust the fit. The dogbone will then fit more snugly.

Steering Servo not working

Test the steering servo by unplugging the steering servo and throttle servo from the receiver and then swapping the plug positions.

This should mean when you steer, the throttle servo should move and when you move the throttle lever, the steering should move.

This is just to test if a servo is faulty.

The steering should not be too stiff. To check this, disconnect the steering from the steering servo. To do this, just remove the one screw which holds the servo horn onto the steering servo.

Once you have done this, try moving the steering by hand and see if it is still tight.

Doing the above eliminates whether the problem is the servo or something in the steering assembly.

Wheels Spinning in opposite directions

It is normal for the wheels to turn in different directions when you spin them freely. Most RC cars have a differential which enables a car to go around corners.

Tyres falling of rims

On our race cars we use a bead of Cyanno glue (super glue) around the rim to secure the tyre.

Shocks Leaking

It is quite normal for the shocks to leak a small amount of oil however not an excessive amount. If one leaks excessively then the shock needs replacing or rebuilding.

The reason they often leak is due to excessive pressure inside the shock from the expansion of the air inside the shock due to heat. This will happen without the car being used. At night when the temperature is cold, the air inside the shock will shrink, sucking in more air; the next day as the temperature heats up the air will again expand and force out. This can also allow a tiny bit of oil to come out too. This is quite normal and the shocks on model RC cars need to be regularly topped up.

Electric Cars

See also troubleshooting electric and Nitro, and Radio Control

Battery not charging - not warming

If the battery is not charging, it may be faulty. However did you plug the battery in AFTER the charger was turned (powered up)? With some chargers if the battery is plugged in before the charger is turned on then the battery will not charge. With these chargers the power light on the charger must be on before the battery is plugged in.

Engine does not work or jerky

This is normally caused when the cars main battery is low. Are you able to measure the voltage of the car battery with the car running using a multimeter? The battery should show > 7 volts when plugged into the car with the engine running and the wheels off the ground i.e car sitting on block of wood or similar

To measure the battery voltage, slide the multimeter probes around the wires on back of the plug, there is just enough room to do this.

Also, if you can, check to see if any of the following plugs have come loose in transit.

Steering servo plug (where the Steering servo plugs into the receiver)

ESC (Electronic Speed Control) plug (where the ESC plugs into the receiver)

ESC to Engine plugs

Switch to receiver

Please note: All 3 receiver plugs are plugged in with the black wire normally to the outside of the receiver.

ESC to Motor plug

Crystals, there are 2 crystals, one on the transmitter and there is one on the receiver.

Smoking engine

Smoke from the motor is usually caused by the motor running excessively hot. This can be caused by too much resistance on the car i.e long grass, hot ambient temperature, over gearing, dirt in the engine etc.

If there is dirt in the engine, just remove the bell housing and clean it out with compressed air and / or methylated spirits.

Trouble Shooting Radio Control

Controls reversed

Check the transmitter settings - it is possible to switch the transmitter settings (hand controller) between normal (NOR) and reversed (REV). By flicking the switch to normal this problem should be fixed. *See radio control*

Interference 1 - Engine goes when steered - Electric Car

If the car fails the range test and acts like it is getting interference then this could be caused by one of the following;

- a. One of the plugs has come loose and need to be pushed back in.
- b. The batteries are low.
- c. The transmitter aerial is not screwed in completely or may not be touching the terminal inside the transmitter.
- d. The copper wire inside the aerial on the car may have broken when the aerial was threaded through the aerial tube.
- e. The ESC is not giving the receiver enough power.

Radio Control not working – Nitro

Check that the aerials are fully extended and screwed properly in. Also that the batteries are fully charged and there are 8 in the transmitter and 4 batteries in the car. Make sure the transmitter aerial is not over tightened as this can loosen the aerial mounting screw in the transmitter.

Check to make sure the crystals are fully pushed in as well as the all of the receiver plugs also fully pushed in.

Also unplug all the plugs on the receiver and replug them back in.

Radio control not working – Electric

Check that the aerials are fully extended and screwed properly in. Also that the batteries are fully charged and there are 8 in the transmitter and the one large battery in the car. Make sure the transmitter aerial is not over tightened as this can loosen the aerial mounting screw in the transmitter.

Check to make sure the crystals are fully pushed in as well as the all of the receiver plugs also fully pushed in.

Unplug all the plugs on the receiver and replug them back in.

Shaking Servos

This problem is normally caused by low power from the batteries especially on 1/8 scale trucks. The steering servos on 1/8 scale are very powerful and this can cause the battery voltage to drop below 4.8 volts. Rechargeable batteries work best.

LINKS

<u>RC Car Manufacturers</u> CEN Racing www.cenracing.com HPI Racing www.hpiracing.com HSP www.hispeedmodel.com Losi www.losi.com Duratrax www.Duratrax.com Ofna Racing www.ofna.com Parma/PSE www.parmapse.com Tamiya www.tamiya.com Team Associated	<u>Forums</u> www.rcgroups.com www.rcuniverse.com <u>Radio Control Manufactures</u> Futaba www.futaba-rc.com Hitec www.hitecrcd.com Spektrum www.spektrumrc.com <u>Body Shells</u> Hot Bodies www.hotbodiesonline.net Electronic Speed Controllers /Brushless Motors LRP
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I highly value your comments and suggestions on this book. Please share these with me at neil@rcfactoryoutlet.com.au

Neil Waterhouse